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THE LUNAR WORLD
ITS SCENERY MOTIONS ETC

THE LUNAR WORLD.

Plate VI.]

LUNAR CRATER.

THE

LUNAR WORLD

ITS SCENERY, MOTIONS, ETC.

CONSIDERED WITH A VIEW TO DESIGN.

BY JOSIAH CRAMPTON, A.M.
RECTOR OF KILLESHER,
Author of 'Descriptive Astronomy,' 'Recent Discoveries,' etc.

> "There is one glory of the Sun, and another of the Moon."
> 1 Cor. xv. 41.

EDINBURGH
ADAM AND CHARLES BLACK
MDCCCLXIII.

~~180. e. 129~~.
184. c. 49.

BIBLIOTHECA·BODLEIANA·
DOMINUS ILLUMINATIO MEA

PRINTED BY R. AND R. CLARK, EDINBURGH.

PREFACE.

It is a remarkable circumstance, that the increase of telescopic power has not done so much in the way of discovery upon the surface of the Moon as might naturally be expected, and as it *has* done in reference to other astronomical objects, such as the nebulæ, etc.

None of the dreams of speculators upon a new world have as yet, at least, been realized in the case of our satellite; and what is *now* seen with monster telescopes is only what has been seen in the days of Galileo, Huyghens, and Newton, with instruments of more moderate pretensions, but a little more magnified in the present day. A gulf of space, however, still remains between us and our nearest neighbour in the heavens, which it is still questionable whether it will be permitted to man ever to pass.

If, indeed, there is a possibility or probability of it, it will be at least tested by the two gigantic and magnificent rival instruments in preparation for it—viz., Lord Rosse's reflector and Mr. Craig's refractor. If two eyes be better than one, we may naturally expect that two giant telescopes will do more than one; but the former of these, as was suggested at the meeting of the British Association at Belfast, last Autumn, by the President, is to be directed by its noble proprietor to a systematic and close survey of the lunar regions: and as Dr. Robinson has stated that a space of seventy yards on the lunar surface can be distinctly seen with this wonderful instrument, whose powers have hitherto been chiefly confined to nebulæ, we may naturally expect some additional and interesting discoveries from this effort. Enough, however, has been seen by astronomers, and even by the author himself, in a more humble way, and with instruments of far inferior power, to assure him of the general configuration and nature of the lunar surface, as described in the following pages, and illustrated by the accompanying plates; while the perfect knowledge of lunar motions that has been attained, seems admirably adapted to set forth the glory of Him who has ordained them expressly for our benefit. For this end and object, indeed, chiefly the sketch that follows has been designed: the facts have been collected, not only from the best works and the most recent authorities, but from the author's own personal observation of nearly fifteen years, carried on as a delightful and ennobling recreation, rather than a study; but the labour of collecting the facts for the press, and putting them in a popular form, free from technicalities, interrupted continually by more pressing and important avocations, together with the scantiness of opportunity for observation in this variable climate, has not only delayed the publication beyond the time anticipated, but must plead as an apology for the many imperfections that will doubtless be perceived in it. The design of this work, however, as already stated in reference to its predecessors, is not simply astronomical or scientific. Many such treatises exist far superior for those who like them. It is the religion of astronomy which it is the desire of the writer of these pages to unfold; and it is to be lamented that comparatively few treatises of this nature upon scientific subjects are to be met with.

However needful science may be, there is one thing more "needful;" and adopting the sentiments of the Rev. Leigh Richmond, expressed to his children upon this subject, the writer desires to say—"I will never consent to shut God out of His own universe, or divorce science and religion, which He has joined together to dwell with each other in unity and love." To this treasury of God in the world of nature, then, the author here throws in his mite, earnestly praying that the perusal of the following work may be blessed to those who read it, as God alone can bless it.

"For never yet did philosophic tube,
That brings the planets home into the eye
Of observation, and discovers, else
Not visible, His family of worlds,
Discover Him that rules them; such a veil
Hangs over mortal eyes, blind from the birth,
And dark in things divine. Full often, too,
Our wayward intellect, the more we learn
Of Nature, overlooks her Author more;
From instrumental causes proud to draw
Conclusions retrograde, and mad mistake.
But if His Word once teach us—shoot a ray
Through all the heart's dark chambers, and reveal
Truths undiscerned but by that holy light,
Then all is plain. Philosophy, baptized
In the pure fountain of eternal love,
Has eyes indeed; and viewing all she sees
As meant to indicate a God to man,
Gives him his praise, and forfeits not her own."

COWPER.

J. C.

PREFACE TO THE SECOND EDITION.

The author is happy to have it in his power to add to this edition, through the kindness of Mr. NASMYTH, of Manchester, valuable and interesting original information respecting the lunar surface, the result of a communication with that gentleman upon the subject, whose labours and discoveries in that branch of astronomical research have attained European celebrity.

PREFACE TO THE FOURTH EDITION.

The present edition has been carefully revised, and it is hoped improved by many additions and references to recent observations upon our satellite. The treatise upon the Habitability of the Moon and Plurality of Worlds, now for the first time added to this volume, was originally intended as a reply to certain observations made by Sir David Brewster* upon the opinions expressed in this work upon the present condition of the moon.

The author now takes the opportunity afforded by the present edition of appending that reply in its proper place, with additional illustrations and notes.

While he regrets being obliged to differ from that eminent astronomer in this one particular, and while thanking

* "More Worlds than One," page 107.

him sincerely for his kind approval and notice of other portions of the work, he is glad to express his cordial agreement with Sir David in the wider and more important subject of the plurality of worlds, so ably and beautifully exhibited by him in his delightful volume "More Worlds than One."

The partial revival of a subject so fully and ably discussed but a few years ago, may perhaps (to some) appear superfluous. But, so long as there is a moon to look at and eyes to behold it, so long the subject will have an interest, and so long as the improvement of telescopic vision remains an unknown quantity, so long will such a question as her habitability continue to be discussed ; while the planets, too, with their attendant moons, and other strange terrestrial analogies, beam upon us nightly, inviting our attention and investigation, so long will the busy mind of man, unsatisfied with former discoveries and conclusions, press on to new ones, and recur again and again to the magnificent conception of an infinite plurality of worlds.

That the habitability of the moon, however, is not the first inductive step to this great conclusion, the writer is fully satisfied. It rests on other higher and different species of evidence. In the consideration of this great question, the Philosopher and Astronomer must enter the province of the Christian and the theologian, where (in the writer's mind) far more positive evidence seems to be afforded to its truth than is derived from astronomy, which should rather be used for its *confirmation*, than its first *establishment* as a doctrine.

With this view of the subject, however, the present treatise has little or nothing to do, being confined chiefly to the astronomical evidence. The author prefers reserving for another opportunity the full weight of Scripture testimony for a doctrine to which, as he conceives, astronomical observation does but set its seal.

VIOLET HILL, FLORENCE COURT,
December 1862.

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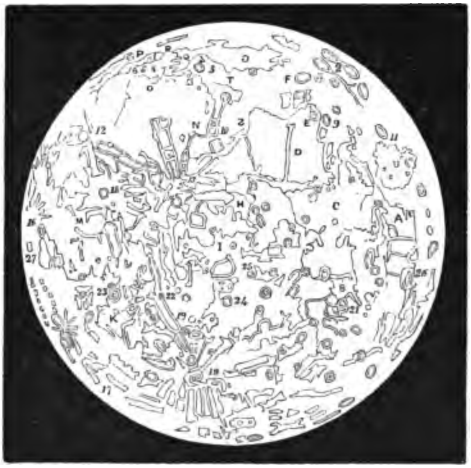
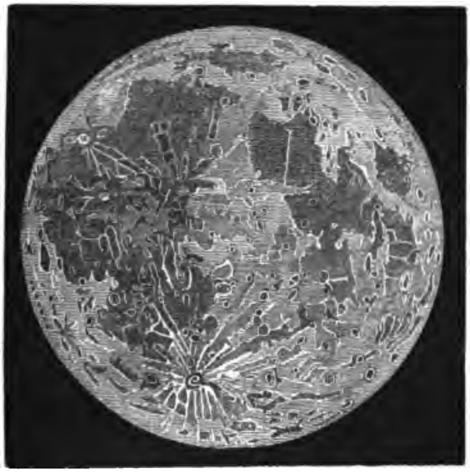
The Lunar Maps represented in Plates I. and II. are intended as a guide to the places which are of interest upon her surface; Plate II. being the appearance she presents to the eye, and Plate I. a key to the various spots, consisting of mountains, craters, etc., which are numbered in the catalogue. The Maps of the Moon by Messrs. Beer Mædler are the most minutely accurate; but the following (from the Penny Cyclopædia) seem better adapted for popular use.

Plate I.



1. Pythagoras.
2. Endymion.
3. Plato.
4. Aristotle.
5. Hercules.
6. Atlas.
7. Heraclides falsus.
8. Heraclides versus.
9. Posidonius.
10. Archimedes.
11. Cleomedes.
12. Aristarchus.
13. Eratosthenes.
14. Copernicus.
15. Kepler.
16. Hevelius.
17. Schickardus.
18. Tycho
19. Pitatus.
20. Petavius.
21. Fracastorius.
22. Bullialdus

Plate II.



23. Gassendus.
24. Arzachel.
25. Ptolemy.
26. Langrenus.
27. Grimaldus.
A. Mare Fæcundatis.
B. Mare Nectaris.
C. Mare Tranquillitatis.
D. Mare Serenitatis.
E. Lacus Somniorum.
F. Lacus Mortis.
G. Mare Frigoris.
H. Mare Vaporum,
I. Sinus Æstuum.
K. Mare Humorum.
M. Oceanus Procellarum.
N. Mare Imbrium.
O. Sinus Iridum.
P. Sinus Roris.
Q. Terra Pruinæ.
R. Terra Siccitatis.
S. Palus Nebularum.
T. Terra Grandinis.
U. Mare Crisium.

CHAPTER I.

Comparative Geography of the Earth and Moon — Terrestrial and Lunar Maps—An Island World in the Heavens—A Midnight Diorama—The Journey—Mode of Travelling—Sketches of Lunar Scenery—First Flight through Space—General Survey—Appearance of the Moon on approaching her—Obstacles—Disappointment—Incredulity—Explanations—Second Flight through Space—The Real and Ideal.

It is a curious, and, indeed, an humbling reflection, that it has taken man six thousand years to become even tolerably acquainted with this world, in which the Almighty has placed him. Slowly and gradually, when measured by time, though but momentarily when compared with eternity (as emmets disperse themselves over their hillock), he has extended the bounds of his habitation, and enlarged his knowledge of the globe on which he lives, till he has almost grasped the problem of the universal geography of the earth; and a few years more will probably bring about the strange result, of a child of the dust being enabled proudly to say—"With the exception, indeed, of those icy pinnacles, where no human foot could stand; or those sun-scorched, airless deserts, where no lungs could breathe freely; or those impenetrable forests, through which no human force could make its way—there is not a spot on this wide world now where I have not been—there is not a country or a clime with which I am not acquainted—there is not an ocean that I have not sounded, nor a sea that I have not traversed, nor a mountain that I have not climbed—there is not an island strand (however lonely) where the keel of my boat has not grated—there is not a river that I have not traced to its source—nor a nation, or a people, or a city, that I have not recorded in my map."

This climax is not so far off, perhaps, as some think; and with the exception of Central Africa and Australia, but little remains to be learned of the earth, geographically. In the meantime, however, the busy mind of man has not been idle; and, baffled for a while in obtaining a perfect map of his own world, he has turned his eyes and attention upwards, and absolutely entered on the geographical—or rather, selenographical—examination of a neighbouring world, *i.e.*, our own beauteous satellite—another house, apparently, in the boundless city of heaven—another island in the blue ocean of space—another bright mansion in the glorious palace of God—a silvery globe—an illuminated map, hanging suspended, as it were, in mid-air, for our nightly inspection. He has gladly availed himself of the opportunity; and, arming himself with a giant's eye, when the air is calm and still, and the moon rolls in quiet beauty through the firmament, the astronomer has taken his post, and, amidst the deep silence of night, and the profound repose of nature, has examined and scrutinized every feature of her shining landscape. While others are wrapped in slumber, he is climbing her mountains, and traversing her plains, and crossing her valleys. He has already measured her depths, and scanned her heights, to a foot. He is standing, on a lunar morning, upon her golden mountains, to see her sunrise; he is gazing, on a lunar evening, at the fast-retreating light, as it vanishes from her mountain-peaks, and the swift-coming shadows, as they creep over that solemn plain, across which he has already in spirit travelled for 1500 miles. In short, everything that *could be* done *has been* done in the way of observation; and then the micrometer has been at work, and a scale has been made, and a map formed more accurate by far than any terrestrial map, containing every winding of every bay—every rocky promontory—every steep defile—every mountain and vale—every hollow plain and river, if such a thing exists—until there is not a peculiar feature of her scenery, or a spot on all the surface she presents to us, to the space of one hundred yards, that is not recorded for our inspection. But this is not all: what the human hand could not effect, or, at least, effect imperfectly, the human mind has contrived to do, by the adaptation of the most wonderful and beautiful of modern discoveries, so that the silvery map in the heavens, at a distance of 240,000 miles, is made literally to transfer its own impression to a metallic plate, in the hands of the astronomer on earth, with every lineament and minutia of her face imprinted and described with a divine accuracy and perfection, which increases in proportion to the magnifying power applied.*

Thus, we have an island world in the heavens revealed to our gaze; and ere long, no doubt, these photographic maps will be in every one's hand; and while the astronomer continues still to search with his wondrous instrument, whose power and capabilities seem to be daily increasing, each of us will be enabled to lay his map before him, and, with a small magnifier in our hand, to trace out every feature of our neighbouring world.

---

* Note A.

But, what has been done hitherto in the way of discovery in this strange land—what facts have been ascertained—what *may* be seen, and what *has* been seen—on such a survey; and what are the conclusions which we are led to form respecting the nature of the lunar globe, are questions which it is the purpose of this little sketch to reveal.

That the chief intention of the Almighty in giving us a moon was to give light to the earth, is plain; as the sun is "to rule the day, so the moon is to rule the night;" that there are many other equally, if not more important objects it subserves, such as the regulation of the tides, etc., a comparatively slight acquaintance with her astronomical condition as our satellite can shew;—these shall be considered in their place. But we are at present merely regarding her physical condition—looking *into* her rather than *at* her; and we want to know, not so much what she does *for* us as what she *is* herself, both geologically and geographically; whether, from such an examination of her surface, we are to regard her as a world like our own, or as a desert rock and unpeopled solitude; as a mere lamp and regulator for the earth, or as an independent sphere, suited for intelligent creatures, and possessing resources within itself accordingly. While it is not likely, indeed, that we shall ever be in a position to arrive at *absolute* certainty in the matter, yet a number of probabilities may be put together, which will afford at least presumptive evidence as to the conclusions that may fairly be drawn; and give an opportunity for an inquiry of no slight interest, and the exhibition of a country, not, perhaps, as well known or as familiar to many of the readers of this work as to the writer.

In order to answer these questions satisfactorily, then, I would at once propose a short excursion to the moon, and ask my readers to accompany me. When there, I will endeavour to point out each feature of interest, as it presents itself to view. The machine, or vessel, that I have provided for our journey is of very simple, and, indeed, somewhat ancient construction : it consists of a tube of tin, ten feet long, and six inches in diameter, to which are adapted certain glasses, or lenses, and brass tubes, by the aid of which different powers of locomotion can be applied, and, with the velocity of light, we can be thus transported to within a few miles of the country we purpose to visit; from which undisturbed elevation in space, looking down (as though seated in the car of a balloon, on a calm, clear day), we can take a bird's-eye view of lunar scenery. Indeed, the sketches that accompany this work have been thus taken, the shapes of the mountains having been copied from their shadows, and the craters in like manner, as accurately as circumstances would permit; and the landscape afterwards reduced to the natural perspective in which it would appear to a person on the surface, instead of beholding it from a height.

If somewhat of the ideal has been found necessary to be introduced, in order to fill up the details of these views, it can at least be affirmed, that as delineations of the general and main features of that strange land, they are correct; and will, probably, help to convey a better idea of its real character than any mere diagrams could, to persons unaccustomed to telescopic observation.

And now for the first flight through space.

Choose a fine, clear night, when the air is calm and still, and the dew is dropping from the dew-cap of the telescope. Apply a power of sixty.* What was matter of conjecture before respecting the nature of the moon, is now become unquestionable certainty. The globular form of our satellite is now distinctly perceptible; she has widened in her dimensions considerably, and she appears as a huge ball of molten silver, suspended, without any support, in the dark blue æther that surrounds her. But her surface also is changed: she is evidently a solid body of rock, or some such substance, and she is perforated with innumerable holes, rents, and fissures, of every size. The tracing of the dark patches, called seas, are there still; but their character is evident—they are not seas, but dry depressions below the surface—the bottoms of oceans, now no more, or the cradles for future waters; but nothing of this kind covers them now. They, too, are perforated with holes innumerable; huge rocks are scattered here and there over their surface; no lunar cloud ever obscures them. They are sandy or rocky plains, of different depths and extent; and, as is the case in the bottom of our seas, are bounded in some places by a steep ridge or chain of mountains.

But advance nearer to this wondrous object—take another huge stride through space, and at once the reality bursts upon you. You are approaching no minute body, as she appears to the naked eye—no small, bright, calm, and lovely star—but a huge world, and a world of apparent disorder, of fearful wreck and ruin.

But here we may observe, that, as in approaching the shores of an unknown country or island, in a ship, many optical deceptions exist, which prevent us from forming a correct notion of the nature of the soil, so in the first glance at the moon which persons unaccustomed to telescopic observation give, but little idea is generally obtained respecting the nature of the object which they see; and much disappointment has been felt and expressed, simply from the unreasonable expectations that have been formed.

---

* Note B.

The moon, although resembling our world in some particulars, seems (as far as we can ascertain) to be very different in others; as different, indeed, in its general aspect and appearance, in all probability, as the earth we inhabit once looked in its primeval state, previous (geologically speaking) to its sedimentary and tertiary formations, and alluvial deposits. To this we may add, the great distance at which, even under the most favourable circumstances and the most powerful telescopes, we can behold her—a power of five hundred, which is the highest that can be used with advantage, leaving us still at a distance from her of nearly 500 miles, while a power of 10,000, were it possible to apply it with distinctness, would bring us no nearer than twenty-four miles; and the highest magnifying power yet applied will only enable us to perceive, and that as a visible point, an object whose diameter is from 70 to 100 yards, or about 300 feet. If to this be added the inexperience of three-fourths of those who look through a telescope, and the infirmity of vision of others, together with the utter incapacity of many to judge of distance, perspective, etc., we shall not be surprised at the disappointment of some, and the scepticism of others, at what they call the pretended discoveries of astronomers in the moon, when they compare them with their own unpractised observations, and the unmeaning figures that appear to present themselves to their view the first time they get a glimpse at her through the telescope, particularly as having always heard there were mountains and valleys to be seen, they expect to see them exactly as they would a terrestrial landscape, or as they are delineated in the sketches in this book ; which they never can, being seen from a height, when the diameter of their mountain summits, or hollows of their craters, alone can be perceived.

In the face, however, of such obstacles, we advance in our telescopic vessel nearer to this island-world ; and although to the inexperienced eye it may look like the sugar on a huge frosted plum-cake, or a globe of alabaster or plaster of Paris, magnified—pierced with innumerable holes, and raised with numberless excrescences—we are enabled, viewing it with an astronomical eye, to see a round world, 2000 miles in diameter ; in those holes, to recognise its valleys and craters ; in those excrescences upon its surface, its lofty mountains ; in those dark shadows, its vast plains. Once get the conviction of this fact upon the mind—a fact, be it remembered, previously demonstrated by the most rigid laws of mathematics—bring the imaginative power to aid in the work of transporting you there, and the search after the picturesque—either the calm and soft, or the gigantic and terrible, as they are exhibited in lunar scenery—will be not only easy, but delightful ; while there will be as little difficulty experienced, after some practice, in giving to the objects we see on such a small scale their real magnitudes and proportions, as there is in giving them to the features of the terrestrial landscape, in the picture that hangs upon our wall within its tiny frame.

CHAPTER II.

Lunar Mountains — Search after the Picturesque — Geological Speculations—Qualifications for Lunar Travelling—Wanderings in the Mare Imbrium—Pico—The Apennines —Bay of Rainbows—Mountain Chains—Terrestrial Analogies—Impression produced by Lunar Scenery—Eratosthenes—Lunar Craters—Wall-surrounded Plains —Radiating Craters.

AMONG the most remarkable features of lunar scenery are her mountains. With these the moon is overspread; they occupy, indeed, not less than two-thirds of the entire disc which she presents to us. Of what nature her surface is composed upon the other hemisphere we can never know, as she presents always the same face to the earth; but from analogy we may fairly conclude it is not materially different. But not only are her mountains more numerous, in proportion to her size, than those of the earth, but they are much larger, rising to a much loftier elevation, composed, apparently, of a substance of a much harder texture than anything terrestrial, and exhibiting bolder and sharper outlines, and more tremendous precipices, some of which project and overhang each other in such a manner as to lead many to suppose that the rocks composing them are of a harder and more solid nature than wrought-iron.

In these particulars, as well as in an extraordinary power of reflection which some of them possess, and which illumines them occasionally as with a phosphoric light, they differ from terrestrial mountains. Of what the substance is of which they are composed, it is, however, of course, impossible to conjecture, except from the stratified appearance which is quite perceptible in some of the precipitous sides of the lunar craters, and which running horizontally, in a terrace-like conformation, has led some geologists to conjecture something similar to that of our trap-rock.

But we continue our telescopic journey; and now that we are about to take our last flight, which is to land us upon the lunar soil, we must call in the imaginative power to our aid; and let us suppose ourselves to be angelic beings, who can exist in any climate, or any atmosphere, or in none—for this is needful for lunar travelling. Adapt a power of about 150 to our aerial vessel, which will be sufficient for our purpose. Choose the period of the last quater; and direct our way to that dark, shadowy spot marked N in the map, and situate at the north-eastern portion of the lunar globe—it is the Mare Imbrium, or Sea of Showers, as it is called, though no water is to be found there, and no shower ever cools or moistens its barren surface. It is about 700 miles in extent every way. Let us cast our eyes around, and what do we see? A boundless plain, or desert, stretching away as far as the eye can reach on every side, save in one or two points, where a chain of lofty mountains can be perceived, whose brilliant, pointed summits, glittering in the sunbeams, just appear upon the distant horizon. The light that glares upon the plain is intense, and the heat of a tropical fierceness, for no cloud shelters us. By that light we may perceive, scattered over the plain, an infinite number of circular pits, of different sizes and depths, varying from a few yards to some hundred in diameter, and sunk in the body or crust of the planet; some of them but a few feet, and others to an unknown and immeasurable depth. Above, the sky is black, out of which the sun gleams like a red-hot ball; and the stars sparkle like diamonds—for no atmosphere such as ours exists, to give by its refractive and reflective powers the delicious blue to its heavens, and the softened shade to its landscape. The lights and shades are indented upon its features deep and dark, or intensely bright; no softening away in the distance, no gentle and beautiful perspective, no lovely twilight—morning or evening—stealing over or away from the scene. All the shadows are abrupt, sudden—all the outlines sharp, clear; appearing startingly near, even when really distant. No sound follows our footfall, or is ever heard in that silent place—for there is no atmosphere to conduct it; no fresh breeze blows on its mountain-tops, sighs through its burning deserts, rustles through the brilliant green of forests, or waves over meadows; the silence of death broods over its arid wastes and rocky shores, against which no tides or billows break.

But onward let us bend our steps towards that magnificent range of mountains, whose peaks glitter on the horizon, some 17,000 or 18,000 feet above the plain on which they stand. This is one of those features on this desolate globe that presents the greatest analogy to our own; nò chain of terrestrial mountains could be more perfectly represented. But what is that huge, dark object to the left, standing alone in this waveless sea? It is Pico, a well-known rock;* 7000

* Situate a little to the north of Plato.

feet perpendicularly it rises from the plain. Its outlines are sharp and pointed; it seems either as if some tremendous convulsion had pushed it up through the soil, or that the surface had as suddenly subsided and sunk from around it, leaving it standing bare, naked, and solitary—casting its giant shadow for miles away over the desert.

But now for the Apennines. Peak rises behind peak, pointed as Teneriffe, but far more lofty; their summits shine like silver, illuminated as they now are by the fast-descending sun, which is stealing away from them, soon to leave them, and the plain upon which every outline of their form is distinctly traced, in the deepest darkness. As we approach them, to the right, we perceive that they form a bend, or curve, extending in a continuous range for near 600 miles; and that they are the boundary of the sea, or plain, in that direction. Their summits are Alpine rather than Apennine—some of them, such as Huyghens and Bradley, attaining respectively to 18,000 and 13,500 feet in height. While they slope away in a gradual declivity at the back, they form a chain of tremendous precipices next the sea, or plain, presenting sharp and jagged outlines, and fearful chasms, whose shapes are distinctly perceptible upon the plain below.

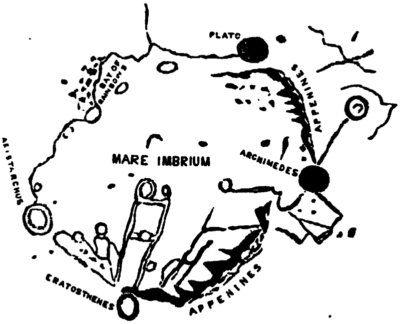
We are now in the Bay of Rainbows, considered one of the most beautiful spots on the moon. Here we are struck at once with the resemblance it bears to many terrestrial scenes that we are familiar with, and there is less effort of imagination necessary to transport ourselves there. Just before, we have been out on the desert plains of Africa or Asia; now, we are spectators of the lofty Himalayas or precipitous Andes; but there is still mingled with this sensation something of the wild and terrible that accompanies us wherever we go on this globe, and of which we cannot ever divest ourselves altogether. There is, indeed, a character quite its own in all lunar scenery (even in the softest and most beautiful parts of its landscape), which never lets you for a moment forget that you are in a land that is "not of earth." The wonderful and extraordinary clearness, the intensity of the light and the blackness of the shadows, the sharply cut and pointed summits of the mountains, the perfectly circular craters, and pits, and caverns, cut as though they had been marked out with a compass before they were hollowed—all this conveys a preternatural and strangely wild appearance. You feel at once that you are in another world, and one of emptiness, and waste, and ruin—a globe that, in its geological history, has passed through fearful times; and, as you survey the desolation of its calmest and softest scenes, and bring them close to your eye, in the dead hour of the night, when there is nothing to interrupt the full impression it produces, you start back with an indescribable sensation—it is that of silence and intense solitude—which creeps over you, till it becomes for the moment oppressive and almost insupportable. You feel at once persuaded, while the eye ranges over those lifeless wastes, that instead of being clothed with verdure, as some have conjectured, or crowded with populous cities and inhabitants, that, if ever there was a realization of perfect solitude, it is there—if ever there were dry places, where lost spirits might be imagined as "seeking rest and finding none," it would be there.

But what are these frowning ramparts, or walls of rock, that stand before us, and seem to prevent further progress? We have now reached the southern boundary of the Mare Imbrium, and the end of the Apennine chain, of which this seems the last link. Over rugged rocks let us ascend for 3000 feet till we reach the edge, and look down. What a scene is revealed! We are on the brink of a lunar crater—it is Eratosthenes, considered one of the most beautiful, though not the largest, of the same class, which may more properly be called wall-surrounded plains. This has been named by Mädler, the mighty key-stone of the Apennines, which its position justly entitles it to be called. (*Plate III., Fig.* 1.)

We are on the edge, then, of a circular rampart, or precipice of rock, enclosing an area or space of thirty-seven miles in diameter, or about one hundred miles in circumference. Far down on the surface of the interior plain below—some 6000 feet, and therefore 3000 feet lower than the lunar surface outside—from the very centre of the circle rises majestically a steep, conical-shaped mountain. For 15,800 feet it shoots its sharp summit into the sunbeams, which bathe it in golden light, while its base is enveloped in sombre shadow. There it stands, frowning in solemn majesty on the rocky waste around, the sole monarch of the space within its dismal boundary; whose silence awes, whose solitude oppresses, and whose terrific grandeur takes away the breath.

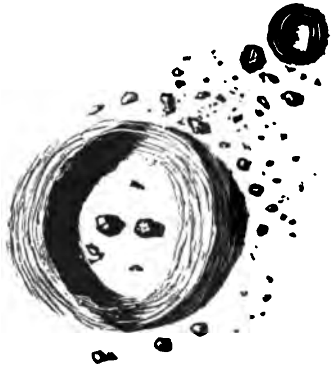
This is a specimen of the general character of the lunar mountains with which her surface is covered—the mountain ranges, or chains, forming the exception. The number of these isolated cones, placed in circular plains or hollows, varying from a few yards to above a hundred miles in diameter, is past counting; but whether standing alone, as some do, or crowded together, till their circumferences break in one upon

Plate III.—Fig. 1.



MAP OF THE MARE IMBRIUM,
WITH THE APENNINES AND THEIR SHADOWS.

Fig. 2.



TELESCOPIC VIEW OF A LUNAR CRATER.
A Sketch from Nature, December 1852.

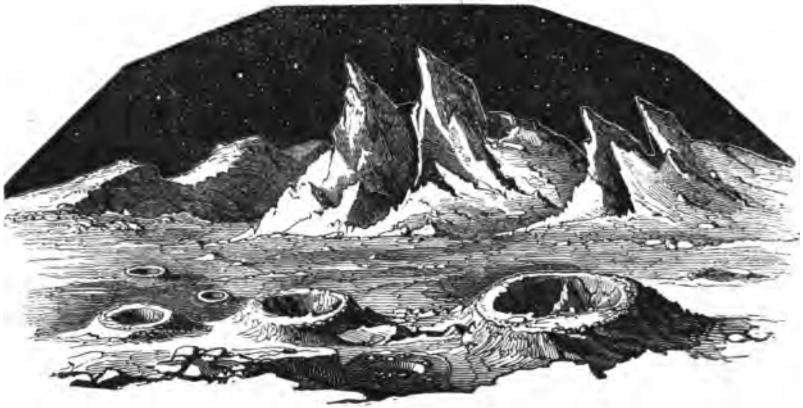


Plate IV.] **THE LUNAR APENNINES, FROM THE MARE IMBRIUM.**

another, like the cells of a honeycomb broken—as they are to be found in the southern portion of the moon, and in the neighbourhood of Tycho—their formation is the same, differing only as to size and depth, and the circumstance of a central mountain—some having none, while others have two or more; while across some a ridge extends, running either the whole or only part of the way; while in the centre of some a deep gulf seems to open. The surface of these circular plains affords a variety of colouring, which, with our present powers of vision, cannot be satisfactorily accounted for—some being of an ashy grey (a colour which generally belongs to those *without* any central mountain), others being of a whitish shade, some few of a red colour, and others of a faint green, which has led some to suppose the existence of a vegetation resembling that of the earth. The shape of the surrounding cliffs can readily be perceived by the shadows they project on the surface of the plain below (*Plate III., Fig.* 2), as we have often seen in the hollows of our mountain lakes, which many of them resemble, if we imagine a sandy plain at the bottom instead of water. When there is a central mountain, its shadow is distinctly cast upon this plain, by which its shape can be ascertained and sketched, and its height measured trigonometrically.*

Thus are we led to perceive, that while our satellite possesses some features in common with her primary, the nature and general distribution of her surface is very different.

There have been many speculations upon the cause of this singular crateriform structure, of which the earth seems to afford but comparatively few analogous specimens. The natural and usual solution of the question, however, hitherto received has been, that it owes its origin to volcanic forces of a similar nature to those in operation upon our own globe; and that Etna, Vesuvius, Teneriffe, and Hecla, together with the other active or inactive cones of disturbance, are the types of the lunar, which they seem to resemble in many particulars; only instead of being confined to a few points, as here, they operated universally over the lunar surface, as we should find *was* probably the case upon the earth before her sedimentary deposits had covered, as with a garment, the naked and torn bosom, now so fertile; which was designed to be afterwards a habitation for God's last and greatest work.

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* Note C.

I am inclined to think (though, of course, it is a question that does not admit of positive proof) that this is the true history of lunar disturbance, although it must have been of a peculiar character, and of a very violent nature. A remarkable evidence of this, indeed, is afforded by a peculiar feature in lunar scenery. There are some of her craters to which the name radiating has been given, from the appearance of straight, white lines, which radiate from them in every direction, like the glory round the head of saints, and extend, some of them, to a vast distance across the surface of the planet—sometimes crossing each other, but pursuing their course, like our railroads, only accommodating themselves to the nature of the ground, without suffering anything to impede them or turn them aside into the slightest curve; now ascending mountains, and now descending into the very bottom of craters, cutting them, as it were, in two, without the least deviation. One of these remarkable lines can be perceived with the naked eye, proceeding from the crater called Tycho, situated in the southern portion of the moon's hemisphere, where, probably, the greatest disturbance has taken place, and where craters and mountains are crowded upon one another, in wild and terrible profusion. This line that thus radiates from Tycho (which is a vast, deep crater, with a central mountain, and a chasm fifty-five miles across) spans nearly the entire disc of the moon, and can be perceived with a telescope, as a white, shining line, crossing the Mare Serenitatis, having run a course of nearly 1700 miles! The full moon is the best period for observing these rays, which, as they generally throw no shadow, have somewhat perplexed astronomers. The explanation usually given, however (which is probably the truth), is, that these radiating craters were successively the centres of a terrible convulsion,* which operated on the crust of the moon as the blow of a stone would upon a piece of plate-glass, sending out sloping but elevated ridges in all directions from the centre of disturbance.

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* As the rays from different craters cross each other, they are observed to eclipse, or conceal one another at the points of intersection, evidently according to the age or chronological era of the crater, whose rays thus, like the hands of a clock, point out the order and time of the successive eruptions—and, probably, the original formation of each crater. Professor Nichol thus clearly explains this theory:—"If a ray or vein from one granite cuts the vein of another granite, we instantly infer the posteriority of the former. Now, I find that rays from Kepler cut through rays from Copernicus and Aristarchus, while rays from Aristarchus also cut through rays from Copernicus; there is, therefore, no doubt whatever as to the ages of these interfering streams. They stand in this order—Copernicus, Aristarchus, Kepler."—*Nichol on the Solar System*, p. 165.

CHAPTER III.

Tycho — Copernicus — Chaotic Scenery — Volcanoes — Water — Atmosphere — Different Conclusions respecting the Lunar World — Speculations — Facts.

Among the radiating craters, the most considerable in size and importance are Tycho, Kepler, Plato, and Copernicus. The former of these to which we have already alluded is, perhaps, the most remarkable, and the best worth a visit, when it is in a favourable position for telescopic observation, which is about the period of half moon. It lies in the southern part of the lunar surface, and can be plainly perceived with the naked eye at the full moon, being one of the most conspicuous objects. An attentive observation of it and its vicinity, with the telescope, reveals a scene unparalleled by anything terrestrial.

We are in the highlands of the moon here; but the grandeur of the glacier solitudes of Mont Blanc is presented to the eye, mingled with the frowning precipices of the Andes, or the ashy desolation of Hecla; far as the eye can reach on every side, mountain-tops and ridges stretch away interminably, so as not to present one spot of level ground on which the sole of the foot could rest, varied by the gaping mouths of deep caverns or pits, of unknown depth, into the bottom of which the sun never shines, and with which this chaotic part of our smiling satellite is absolutely honeycombed.

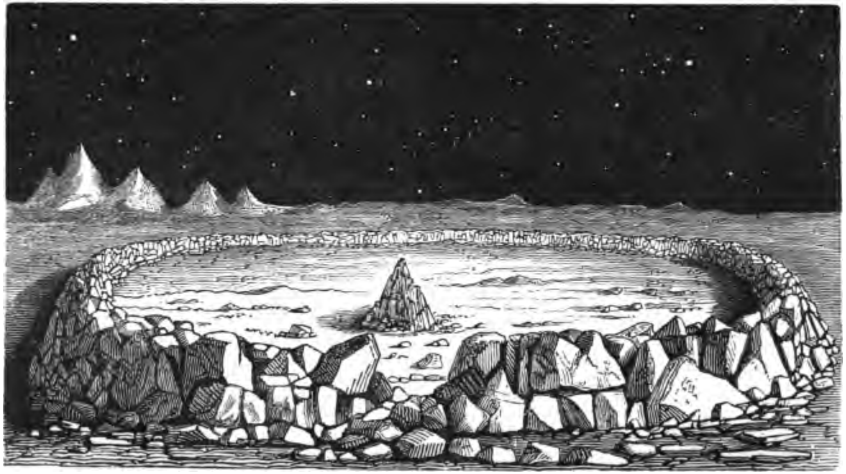

Plate V.] WALL-SURROUNDED PLAIN IN THE MOON.

With a telescope of small power it is, indeed, a very beautiful sight, and appears like a golden lace-work; but when you examine it closely, it is very different. If any part of the moon be inhabited (which is more than improbable, indeed, from the knowledge we have now of her condition), certainly this part is likely to be an exception, for never did eye gaze upon a wilder or stranger scene. Let us, in imagination, stand for a few moments within the arena of Tycho. Around us, on every side, rises a mighty wall of rock, extending in a circle of 150 miles, or 54 in diameter. Looking up from the interior plain, it is 17,000 clear feet of precipice before the eye rests. Before us extends a plain for about 25 miles, interrupted, however, by concentric ridges of rocky mountains, or barriers, that encircle (in irregular and broken masses, of fearful magnitude and height) the awful centre, whence, from a black and profound gulf, that opens its mighty jaws, springs a huge, dark mountain—the Sinai of Hevelius—whose steep and pointed summit, higher than the lofty Snowdon, shoots upward for above 4000 feet in sheer precipice from the plain. The centre, this, of the terrible convulsion that once shook the very heart and substance of our satellite: so that it would seem, indeed, that it needed but little more to burst the entire globe, and scatter it into fragments.

The awful character of such scenery is feebly represented by anything terrestrial analogous to it. Were we to seek it anywhere, it would be in the wilds and desolation of Hecla, which, by the following description of a modern lady traveller, it seems to resemble not a little:—

"Suddenly, as if by magic, I found myself standing on the brink of a chasm, into which I could scarcely look without a shudder; involuntarily I thought of Weber's *Freyschütz* and the 'Wolf's Hollow.'

"The scene is the more startling from the circumstance that the traveller approaching Thingvalla in a certain direction sees only the plains beyond the chasm, and has no idea as to its existence. It was a fissure some five or six fathoms broad, but several hundred feet in depth; and we were forced to descend by a small, steep, dangerous path, across large fragments of lava. Colossal blocks of stone, threatening the unhappy wanderer with death and destruction, hang loosely in the form of pyramids and of broken columns, from the lofty walls of lava, which encircle the whole long ravine in the form of a gallery. Speechless, and in anxious suspense, we descend a part of this chasm, hardly daring to look up, much less to give utterance to a single sound, lest the vibration should bring down one of those avalanches of stone, to the terrific force of which the rocky fragments scattered around bear ample testimony. The distinctness with which echo repeats the softest sounds and the lightest footfall is truly wonderful.

"The appearance presented by the horses, which are allowed to come down the ravine after their masters have descended, is most peculiar. One could fancy they were clinging to the walls of rock.

"This ravine is known by the name of Almanagiau. Its entire length is about a mile, but a small portion only can be traversed; the rest is blocked up by masses of lava heaped one upon the other. On the right hand, the rocky wall opens, and forms an outlet, over formidable masses of lava, into the beautiful valley of Thingvalla. I could have fancied that I wandered through the depths of a crater, which had piled itself these stupendous barriers during a mighty eruption in times long gone by.

"My pen is unfortunately too feeble to bring vividly before my readers the picture as I beheld it here, and to describe to them the desolation, the extent and height of these lava-masses. I seemed to stand in a crater, and the whole country appeared only a burnt-out fire. Here lava was piled up in steep inaccessible mountains; there stony rivers, whose length and breadth seemed immeasurable, filled the once verdant fields. Everything was jumbled together, and yet the course of the last eruption could be distinctly traced.

"I stood there, in the centre of horrible precipices, caves, streams, valleys and mountains, and scarcely comprehend how it was possible to penetrate so far, and was overcome with terror at the thought which involuntarily obtruded itself—the possibility of never finding my way again out of these terrible labyrinths."—*Madame Pfeiffer's Journey to Iceland.*

Copernicus, although another of the radiating craters, does not show such disturbance; and there is nothing softer or calmer in the scenery of the moon than this crater exhibits, whose bright and branching rays (some of them nearly ten miles in width) shoot out on every side, over the pearly surface of the plain, undisturbed by any commotion comparatively. When the moon is in the first quarter, nothing can be more beautiful than the lights and shadows of the rocky cliffs and walls exhibited by this crater.

The perfectly circular shape, to which we have already referred as the type of the lunar craters, has been attempted to be accounted for by Robert Hooke, the celebrated English mathematician and natural philosopher of the seventeenth century, who, in a work of his entitled "Micographia," published in 1665, put forward the theory of the reaction of the interior of the moon against the exterior, or the effect of subterranean fire and elastic vapour, breaking forth, even to ebullition, and sending up to the surface bubbles, or blisters. Accordingly he made several experiments, by boiling thick calcareous solutions, which, he says, produced similar formations to the lunar craters, as they rose and hardened upon the surface.*

There *are* a few places upon the earth where something much resembling them in shape is to be found.* Indeed, Galileo himself, as Humboldt declares, had been reminded, by a circular wall-surrounded plain in the moon, of the configuration of entire countries, such as the great closed basin of Bohemia, which might be compared to lunar craters of the largest diameter, of which there are two or three; but these, with most of those that cover her surface, are considered more likely to be craters of elevation, *without continuous eruption*, as many of those on our own planet with which we are acquainted.

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* Note D.

There are, however, advocates still for the present activity of lunar volcanoes, and mysterious changes are said to have taken place, and fires to have been observed, upon the face of our placid luminary; which, if correct, would lead to the notion that, peaceful as she appears to us, all was not yet at rest in that disquieted globe.

Thus Sir W. Herschel writes, in 1787, 19th April, 10h. 36m.:—"I perceive three volcanoes in different places of the dark part of the new moon. Two of them are already nearly extinct, or otherwise in a state of going to break out; the third shows an eruption of fire or luminous matter." And again, on the next night, 20th April, 10h.:—"The volcano burns with greater violence than last night; its diameter cannot be less than 3″, and hence the shining or burning matter must be above three miles in diameter. The appearance resembles a small piece of burning charcoal, when it is covered by a very thin coat of white ashes; and it has a degree of brightness about as strong as that with which such a coal would be seen to glow in faint daylight." The foregoing observations led Sir W. Herschel, who, at the time, was in possession of better instruments than any man living, to enable him to determine the fact, to embrace fully the theory of continued activity in the lunar volcanoes, particularly as he saw, or thought he saw, a confirmation of it in the accumulation of matter, not before remarked, as soon as the supposed eruption had ceased.

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* Note E.

To this may be added the observations of the celebrated Schrœter, of Lilienthall, the most persevering and eagle-eyed of astronomers, who, in the Transactions of the Society of Natural Philosophy at Berlin, thus relates, that on the 30th of December 1791, at five o'clock, P.M., with a seven-feet reflector, magnifying 161 times, he perceived the commencement of a small crater on the south-west declivity of the volcanic mountain in the Mare Crisium (marked U in the map), having a shadow of at least 2″ 5. On the 11th of January, at twenty minutes past five, on looking at their place again, he could see neither the new crater nor its shadow. Again, on the 4th of January 1772, he perceived on the eastern crater of Helicon, a central mountain, of a clear grey colour, 3′ in diameter, of which, *during many years' observations, he had perceived no trace.* This appearance, he adds, is remarkable, as probably from the time of Hevelius the western part of Helicon has been forming into its present shape, and nature seems in that district to be particularly active.

It is, perhaps, premature to dispose of these important observations and remarks of the two most eminent astronomers in the world as summarily as more recent observers have done, and to explain them away altogether, as referrible to illusions produced by the reflective nature of the lunar soil, seen by earth-light, reflected from the tops of mountains, at various angles.

It is true, indeed, that such an explanation may in some measure account for the apparent activity of the volcano seen by Sir W. Herschel, which, by a careful comparison with similar observations of others since then, seems to point to the same spot, where a mountain called Aristarchus is to be seen, with a top at times strangely luminous, though variable, but always more brilliant than others; so much so as to be known familiarly as the brightest spot on the moon. This I have frequently seen myself; and when the atmosphere has been in a state of undulation, a vivid motion has been communicated to that spot, bearing a strong resemblance to a volcano in activity; while at other times, when the air has been calm and still, it has shone with a steady, clear phosphoric light.

The observations, however, of Schrœter, with reference to the changes he observed, cannot so readily be explained; and there is nothing improbable in his account to lead us to reject the notion, that in a world so torn by volcanic forces, some great changes, such as he remarked, should still be going on.

But if the moon be peculiar in the formation of her mountains, she is even more so in two other particulars—viz., atmosphere and water. The absence of either of these essentials to a human habitation implies the absence of the other—*i.e.*, if there be no water, there can be no atmosphere such as ours; and if there be no atmosphere such as ours, there can be no water. A fluid there may be, and an atmosphere there may be, in that strange globe; but that fluid cannot be water, that atmosphere cannot be the air we breathe. If the present pressure of our atmosphere were removed from our lakes and seas, the water would boil at a temperature of 72, and go off in vapour. Now, as it may be safely presumed that the same causes will produce the same effects everywhere, if there were water in the moon without atmosphere, or with so little as to amount almost to a vacuum (which is the general opinion), precisely the same effects would follow; and the lunar rivers, or rills, or lakes, or seas, exposed as they would be to the intense heat of a vertical sun for fourteen nightless days, would not long remain there, but would be immediately dissipated. On the other hand, an atmosphere such as ours without water, or, having water, without clouds, would be an equal impossibility. But not the slightest vestige of either clouds or water have ever been seen.

That an atmosphere of *some kind* may exist, is not denied; and although the weight of evidence seems against it, Schrœter and some others affirm the great probability of its existence, although they acknowledge it must be of small extent, and of so great rarity as to amount almost to a vacuum.

The tests that have been most relied upon, as indicating the presence or absence of atmosphere, are two—first, the occultation of a star; and second, twilight.

The occultation of a star by the moon, is the passing of the moon between us and a star. On such occasions it was rightly conjectured, that if an atmospheric envelope such as ours existed round our satellite, the star would not disappear suddenly; but, by the law of atmospheric refraction, would dwell, or hang a little on the edge or surface of the moon, as though it were passing between us and her, instead of behind her, and then, gradually, and not instantaneously disappear.

Now, it is a curious circumstance, that this test, simple and clear as it may appear, has proved wholly inconclusive and unsatisfactory, from the fact, that *both* conditions have been strictly fulfilled, not only as seen by different observers, at different times (which might lead to the conclusion that there was an atmosphere, but that it was variable in density), but by *different observers, on precisely the same occasion, and at precisely the same moment;* which puts such a supposition out of the question. The attention of astronomers had been long called to the fact of the different experience of observers in relation to this matter; some of whom had always remarked the instantaneous disappearance of the star; others, on the contrary, had *occasionally* observed the star to hang apparently upon the surface of the moon, after contact with the edge, and even to advance considerably upon it, as though it were about to cross the face of the moon, as Venus and Mercury do the disc of the sun in transit. Some of the stars likewise were observed to alter their colour during this phenomenon. As this could be explained by the refraction of an atmosphere, the particular attention of astronomers was invited to it by the Royal Astronomical Society; and, with the idea of deciding the question finally, simultaneous observations of the occultation of the Red Star, Aldebaran, were determined upon throughout a great part of Europe; but with this curious result, as may be found in the fourth volume of their memoirs :—" Some, who had not seen the last-mentioned phenomenon, now saw it for the first time; others, who had seen it before, did not see it; some, who had never seen it before, continued unable to do so. Of six observers at the Royal Observatory, five distinctly saw the projection of the star on the moon's limb; and one saw it hang on the edge of the moon, five or six seconds before it disappeared. Of three at the Observatory of Paris, two distinctly saw the projection, and one saw the star disappear instantaneously, leaving a shade on the part of the moon at which it disappeared. The majority saw the star either projected or hanging on the moon's edge. Thus, the test adopted, instead of deciding the matter, left it involved in deeper obscurity; and it is now considered, with much probability, that the phenomenon alluded to is to be accounted for much nearer home, and to be attributed, if not to the telescope in the astronomer's *hand*, to that which is placed in his *head;* and that it is caused by some optical illusion not yet fully explained, in connection with the retina of the eye, upon which the image of the star is painted.

The second test is twilight. This, which we know to be the effect of atmosphere in our own planet, and can readily be discerned in Venus, would afford, it might be thought, a more satisfactory test. But here again astronomers are at fault, some distinctly perceiving it, or thinking they perceive it, while others have never been so fortunate. Among the foremost of the former M. Schrœter is, of course, to be found, who, on various occasions, affirms that he saw a faint grey light, of a pyramidal form, extending from the moon's cusps into the dark hemisphere, which, assuming it to be the moon's twilight, must necessarily imply the existence of an atmosphere. His conclusions upon this observation are, that the more dense parts of this atmosphere are about 1500 feet high; and that the height of the atmosphere, where it could affect the brightness of a fixed star, or inflect the solar rays, does not exceed 5742 feet, or about an English mile. Now, a fixed star will pass over this space in less than two seconds of time; and if it emerge at a part of the moon where there is a ridge of high mountains, scarcely any obscuration could take place that could be perceived.

The evidence for an atmosphere derived from this source (it can be plainly seen) would depend altogether upon the correctness of the observation; and, taking into account the unaccountable imperfections of telescopes, especially in former days, and the great variety of effects produced by the state of our atmosphere, the evidence of Schrœter—important and interesting as it is—does not seem sufficient to establish, beyond all question, the existence of an atmosphere.

And now, what a wonderful place we have been exploring! How different the impression left by a close survey of her scenery and a distant view of her mild radiance! The moon of the astronomer, we see plainly, is not the moon we are acquainted with. One glance through his magic tube, and all is changed. As by the touch of an enchanter's wand the fairy-land of the imagination dissolves; and, in its place, leaves us a dreary solitude. The imagination, which ever loves to speculate where certainty is difficult or impossible, has frequently peopled our attendant satellite with myriads of intelligent and joyous inhabitants; has clothed her landscapes with a more than earthly beauty and verdure, and represented her—as the lovely face she presents to our unassisted vision, and the softened splendour of the beams we admire, might naturally suggest—as the perfection of an earthly paradise. No part of creation, say those who reason thus, is likely to be unpeopled; and it is not consistent with the wisdom and benevolence of God to suppose an empty waste, without an inhabitant, in any part of his dominions. *Therefore* the moon must be inhabited; her mountains are more lofty and magnificent than ours, and her vales covered with vegetation, and arrayed in the loveliness of terrestrial glory. Yet, what are the facts?—what evidence have we for such a supposition? Not a shadow of well-grounded proof, after the many years of close and searching scrutiny directed to the surface of our satellite. Without water, without air, what forms, either in the vegetable or animal world, analogous to ours, could exist; no change or movement of the slightest kind perceptible there—presenting always the same unvarying picture of arid desolation; undimmed by a solitary cloud, unrelieved or undisturbed by a passing shadow, from the top of her loftiest mountain to the extremities of her widest plain. Ever the same, a picture of glittering solitude by day, and ghastly gloom by night; with a climate alternating every fortnight with the heat of the African desert and the cold of Spitzbergen—what are we to think?—That the reasoning that would indulge in the perfect analogy of the moon to the present condition of our globe is unsound, as it is improbable. "One star," it is said, "differeth from another star in glory." This is true, as well with respect to its physical condition as its external appearance. Who that knows anything of the past history of the earth, as it is now revealed by geology, does not see the perfect consistency of a desert state—a state of emptiness and desolation—as one of the periods in the ever-advancing and progressive history of creation; especially as it is shewn in the only planetary body that admits of demonstrative proof, in reference to this point? Indeed, had geology borne no testimony to this truth, the 2d verse of Genesis would, where it is stated that the earth was without form, and void, and was completely submerged with water, and enveloped in darkness. There was a time, then, when the round globe we inhabit was as utterly destitute of, and unfit for, a human inhabitant, as we believe the moon now to be of forms analogous to our own in *any respect;* but as a gradual unfolding and development of animal life is plainly perceptible in the geological strata of the earth, so it may possibly be with the moon. The cradle for future inhabitants it may be ; over those dark plains waves may yet roll, and billows play; over those sterile wastes verdure may yet extend, till it blossom as the rose; the fresh breeze may yet fan the lofty mountain-tops, and wave the green branches of her forests; and her sky may yet be a heaven of blue and gold, and her soil and atmosphere alike teem with life, while over her solitary wastes myriads of inhabitants may yet roam. But, in the meantime, all there is silent and calm, lifeless and dead, as the grave.

This does not, however, destroy altogether the interest connected with her, although it may rob her of much that excites the imagination ; on the contrary, it addresses the mind to a different, but surely not less interesting view of the subject. It directs us at once to the present great and obvious intention of the Creator in placing the moon *where* it is, and making it *what* it is. The greater the desolation, the more obvious the single intention. It is for *us*, then, and *us specially*, it was intended; for this she was placed where she is, to be a lamp and regulator for the earth. It matters not, then, of what she is composed, so as this end is accomplished : so only as she does the work for us, it matters not whether she is an empty waste or a populous sphere. If she was nothing but a volcanic mass of rock, or huge fragment of this, the parent planet, thrown off, according to the beautiful and ingenious theory of La Place, as a condensed portion of a ring of the earth when in a fluid state; however formed, or of whatever material composed, or however arranged physically and internally, so as she complied perfectly with the condition imposed upon her, and fulfilled the gracious design of the Heavenly Architect who planted her in the heavens, and bade her circulate and shine there for our benefit, it matters not: she should be, and is, as much an object for admiration, and wonder, and gratitude, for those for whose advantage she is placed there, as if she were herself the most perfect paradise upon which the Almighty ever lavished his surpassing skill, and wisdom, and glory.

In considering these matters, then, let us take a few thoughts that suggest themselves in immediate connection with this view; and possibly we may find some compensation for the dreary journey we have gone, or the disappointment that may be felt by finding the day-dreams of our imagination melt away under our close scrutiny.

There are two classes of suggestions that offer themselves—the first relating to her utility, the second to her beauty; the first shewing the substantial benefits she confers as our satellite, and the second the impression she makes;—the entire displaying the wisdom that gave us a satellite, and the love that made her what she is to us.

CHAPTER IV.

Utility and Beauty of our Satellite—Use and Advantage of Lighting by Moons—Proofs of Design—Refutation of La Place's Objection.

THE first of the substantial benefits the moon confers upon us is her light; and here we may remark, that of all the modes which the Almighty Architect of the universe has devised for carrying into effect His designs of wisdom, and benevolence, and utility, in the best manner to display His glory, there is none that can exceed that by which it has pleased Him to illumine our nights, and not ours only, but those of other worlds, in this respect, at all events, analogous to our own.

It is a well established fact, that the earth is one only of a number of planetary bodies whose nights are thus relieved and cheered by moons—*i. e.*, by planetary satellites or attendants, acting as reflectors (not originators of light), and differing in number and in size, according to the magnitude of the primary planet, and in proportion to its distance from the sun. Thus, while Mercury and Venus, from their proximity to that body in whose beams they bask, need none, the Earth possesses one, Jupiter four, Saturn eight, Uranus six (as yet discovered), but probably more. Contrivance and intention are here evident, as in the case of the light-houses that cast their friendly beams, from polished mirrors, over the dark waste of water, for the benefit of those who are out upon its surface. The moon, too, is a reflector (though not a polished one, which would not answer the purpose), and casts the solar beams which she receives through the darkness of space, for the benefit of those upon earth, during the period when it is required most; the intention is not so much to remove altogether as to interrupt the darkness, and the contrivance is to do it by reflection. What power and skill has been employed to effect this apparently simple arrangement, we can have little notion of, even after a thorough acquaintance with the complicated movements of our satellite round her primary, and the various duties that she discharges; but merely viewing it with reference to the provision for lighting the earth by a moon, what do we find? The sun has first darted forth his beams, at the rate of 190,000 miles in a second, through more than 96,000,000 of miles of space; in eight minutes it has struck the rough surface of our satellite, an opaque body, not bigger, when compared to the sun, than a grain of the smallest shot would be to a globe two feet in diameter, and from thence it has rebounded 240,000 miles back again to the earth, to scatter a shower of silver light—to pour a flood of midnight radiance and glory over the landscape; and, as she sweeps along over the surface, to cause a series of dioramic pictures of beauty to fall on sea and land, on mountain and vale, on lake and tower, and woodland scene. Thus viewed, how beautifully the designs of wisdom and utility are carried out—how plainly the benevolent intention is apparent in the contrivance. The moon is but a beauteous mirror of the sun, placed where she is by the Divine hand, and for the express and obvious purpose of our benefit. As such, she is a mirror of His own love and wisdom, like the blessed Book He has given us—a reflection of his glory—which "he who runs may read;" or, like that greatest and best gift of His love, so truly and beautifully described by the Apostle, who says—"God, who commanded the light to shine out of darkness, hath shined in our hearts, to give the light of the knowledge of the glory of God, in the FACE of Jesus Christ."—2 Cor. iv. 6. But lighting the world by reflection at night is in itself a proof of what may be called benevolent forethought; it does not seem that any other mode would effect the object as well or as agreeably. Self-generating light, directly communicated, like that of the sun by day, would, as we know, produce *heat* as well as light; but this would be injurious to human life, as well as painful to the sight. Night is the period for the temperature to fall, by the temporary absence of our great luminary, by which nicely-adjusted atmospheric balance an even temperature is sustained, and man is relieved from the burning heat of the day; but were the moon even a small sun, the temperature would be sustained all night, and the atmosphere would soon attain such an accumulation of heat and rarefaction, as to be unfit to breathe.

By the simple arrangement of light by *reflection* at night, when no perceptible* heat is transmitted from the lunar rays, we are preserved from this danger; but the moon is, and must be, as a reflector, not only a lesser light than the sun in magnitude, but a lesser light in intensity than if she was herself a sun; and the intention is plain—viz., to relieve the eyes from the glare and brilliancy of the greater light, which, if continued, would be painful in the extreme. Man, it

* Note F.

is true, is formed for repose, and night is the season for it, when the eyes are generally closed in slumber; but the activity of his mind is such, that there is no night that does not find many millions awake—travellers by sea and land; when the lunar beams are not only useful but delightful, from the change in their character, by which the eye is relieved; and accordingly a light is provided for him without dazzling, and as unlike daylight as possible—a light which shall be sufficiently clear to enable him to discern every object, and to avoid danger, while it is so mild in its lustre, that the eye can never be pained by it, but on the contrary is refreshed and delighted: thus comfort is combined with utility in the conveyance of light to our planet, and the designs of omnipotent and heavenly wisdom are carried out in such a manner as to give pleasure while they confer a substantial benefit.

The careless, and the thoughtless, and the worldly, it is true, may not see this nor value it, and the inhabitants of a large city may not miss her light, in these days of artificial illumination, when as the sun goes down, the glare of ten thousand lamps supplies her place, or vies with her light, leaving our modest luminary only as an object of curiosity or admiration; but numbers of the wild tribes of men and nations of the earth are, notwithstanding, still dependent upon her altogether, while her light is of unspeakable value to individuals and families in districts and places on earth, remote from cities—from the sailor on the wide ocean, to the poor traveller on the dreary moor or in the wild forest. But what a protection her light is even now; night is the time when the wicked are at work, and the robber and the murderer carry on their dreadful trade. We can form but little idea, in the present days of artificial moonlight, and in the civilized portions of the world, what a protection her light affords. In London, even within the recollection of the writer, there was the greatest difference in the amount of danger or risk in walking the streets on moonlight nights, and those intervals of her short absence, when a few miserable twinkling oil lamps made darkness visible. Her value could not be better shewn, indeed, than by the contrivances to supply her place during a former period. Read the following, from Lord Macaulay's "History of England," on the state of London in the days of the Second Charles :—

> "When the evening closed in, the difficulty and danger of walking about London became serious indeed. The garret windows were opened, and pails were emptied, with little regard to those who were passing below. Falls, bruises, and broken bones were of constant occurrence. For, till the last year of the reign of Charles II., most of the streets were left in profound darkness. Thieves and robbers plied their trade with impunity. There was an Act of Common Council which provided that more than a thousand watchmen should be constantly on the alert in the city, from sunset to sunrise, and that every inhabitant should take his turn of duty. But this Act was negligently executed. Few of those who were summoned left their homes; and those few generally found it more agreeable to tipple in alehouses than to pace the streets.
>
> "But, in the last year of the reign of Charles II., began a great change in the police of London—a change which has, perhaps, added as much to the happiness of the body of the people as revolutions of much greater fame. An ingenious projector, named Edward Heming, obtained letters patent, conveying to him, for a term of years, the exclusive right of lighting up London. He undertook, for a moderate consideration, to place a light before every tenth door, on *moonless nights*, from Michaelmas to Lady Day, and from six to twelve of the clock. Those

who now see the capital all the year round, from dusk to dawn, blazing with a splendour compared with which the illuminations of La Hogue and Blenheim would have looked pale, may perhaps smile to think of Heming's lanterns, which glimmered feebly before one house in ten during a small part of one night in three. But such was not the feeling of his contemporaries. His scheme was enthusiastically applauded, and furiously attacked. The friends of improvement extolled him as the greatest of all the benefactors of his city. What, they asked, were the boasted inventions of Archimedes, when compared with the achievement of the man who had turned the nocturnal shades into noon day? In spite of these eloquent eulogies the cause of darkness was not left undefended. There were fools in that age who opposed the introduction of what was called the new light as strenuously as fools in our age have opposed the introduction of vaccination and railroads; as strenuously as the fools of an age anterior to the dawn of history, doubtless, opposed the introduction of the plough and of alphabetical writing. Many years after the date of Heming's patent, there were extensive districts in which no lamp was seen."

It is true that the infidel astronomer and philosopher, La Place, endeavours to destroy its value, and to argue against the gracious intention, by the fact of the temporary absence or invisibility of our satellite. Some partisans, he says, of final causes, have imagined that the moon was given to the earth to afford light during the night; and he says, "this cannot be, as we are often deprived of the light of both sun and moon at the same time," and then suggests the inquiry why the moon should not be always full, if intended to give light; and proposes a plan by which the great Architect of the universe might have accomplished this, for instance, that the moon might have been placed at such a distance beyond the earth, that her periods would harmonize with ours, and thus always present a full face to us. The answer to this is so admirably put by Professor Whewell, that it will be only necessary to quote it:—

"That the light the moon affords is, *to a certain extent*, a supplement to the light of the sun, will hardly be denied. If we take man in a condition in which he uses artificial light scantily only, or not at all, there can be no doubt that the moonlight nights are for him a very important addition to the time of daylight. And as a small proportion only of the whole number of nights is without some portion of moonlight, the fact that sometimes both luminaries are invisible very little diminishes the value of this advantage. Why we have not more moonlight, either in duration or in quantity, is an inquiry which a philosopher could hardly be tempted to enter upon, by any success which has attended previous speculations of a similar nature. Why should not the moon be ten times as large as she is? Why should not the pupil of man's eye be ten times as large as it is, so as to receive more of the light which does arrive? We do not conceive that our inability to answer the latter question prevents our knowing that the eye was made for seeing; nor does our inability to answer the former disturb our persuasion that the moon was made to give light upon the earth.

"La Place suggests that if the moon had been placed at a certain distance beyond the earth, it would have revolved about the sun in the same time as the earth does, and would have always presented to us a full moon. For this purpose it must have been about four times as far from us as it really is; and would therefore, other things remaining unchanged, have only been one *sixteenth* as large to the eye as our present full moon. We shall not dwell on the discussion of this suggestion, for the reason just intimated. But we may observe that in such a system as La Place proposes, it is not yet proved, we believe, that the arrangement would be stable, under the influence of the disturbing forces. And we may add that such an arrangement, in which the motion of one body has a *co-ordinate* reference to two others, as the motion of the moon, on this hypothesis, would have to the sun and the earth, neither motion being subordinate to the other, is contrary to the whole known analogy of cosmical phenomena, and therefore has no claim to our notice as a subject of discussion."

With reference to Mars, as an exception to the Divine arrangement of lighting by satellite reflection, we have the following from the same writer :—

"Mars is a more obvious exception. Some persons might conjecture from this case, that the arrangement itself, like other useful arrangements, has been brought about by some wider law which we have not yet detected. But whether or not we entertain such a guess (it can be nothing more), we see in other parts of creation so many examples of apparent exceptions to rules, which are afterwards found to be capable of explanation, or to be provided for by particular contrivances, that no one, familar with such contemplations, will, by one anomaly, be driven from the persuasion that the end which the arrangements of the satellites seem suited to answer is really one of the ends of their creation." —*Whewell's Bridgewater Treatise*, p. 173.

CHAPTER V.

The Moon considered as a Satellite—Her Movements in Space—Proofs of Design—Lunar Perturbations—Real and Apparent Motion—Phases—The Moon a Magnet.

But the giving of her light is not the only substantial benefit we derive from the moon, nor the only indication of the gracious design of love apparent in the matter; the arrangements by which she accompanies us in our journey—or the circumstances connected with her being our satellite, are even more conclusive. Her motions in space, and indeed the motions of all the satellites, are peculiar, and no other arrangement would seem to fulfil the conditions required so well.

Satellites are small planets attached to the larger ones, called their primaries, in the same way, and by the same great law that attaches us to *our* primary; as we and the other planets are carried round the sun, so the satellites are carried round us; but as we are moving *on* in our great orbit, while they move *round us* in their smaller orbit, they must, necessarily, partake of both motions, viz., *ours round* our great luminary, and their own *round us;* hence they never leave us (their primary), but accompany us in our journey as our constant servants and attendants, *onward* in the vast arc of space, *with* us, and *round,* in the comparatively minute circle by which they engird us.

With respect to our own satellite, simple as the arrangement may seem, the exquisite adjustment and balancing of powers, in order to produce the effects required, is such as not only to fill us with astonishment and admiration, but to assure us as plainly as any piece of workmanship made by human hands can testify, to the working of an intelligent mind for our special benefit, whose Almighty power, and wisdom, and skill, combined in the performance of it, are only to be equalled by the love that has planned it. To say nothing of the wondrous spectacle of a globular lamp provided for us, 6000 miles in circumference, which shall always bear us company, and be bound to us by an invisible cord; to circulate continually around us, and in such a manner that, though varying her distance from us frequently, and deviating from her path considerably, she shall never advance too near us, nor retire too far from us, nor finally abandon us. Not to remark upon the prodigious journey she must accomplish in order to supply our want, having an independent task of her own to perform round us of about a million and a half of miles every month, at the rate of 2000 miles an hour, while she is at the same time carried forward with us in our vast orbit of six hundred millions of miles round the sun, at the rate of 68,000 miles an hour, making in one revolution a lunar journey, annually, of 618,000,000 miles. Not to dwell upon this; the position of the moon in the heavens, and her motions through space in order to produce the beautiful and useful effects we are familiar with, evince a system as admirable in contrivance as it is extraordinary in its working; the perturbations indeed of our satellite, produced by the relative attractions of the sun and earth, form the most complicated and difficult problems in astronomy, and opened an extensive field for mathematical study and investigation, so much so that it is only very recently that every difficulty has been overcome, and a perfect knowledge of lunary motions attained—a task as creditable in the acquirement of it, as it was laborious to those who were engaged in it.*

To give some idea of this: the irregularities of the moon's motions have been divided by astronomers into no less a number than sixty; and although some of them are so slight as to be imperceptible, and therefore not usually taken into account, yet there are about thirty that are generally calculated, without considering which, indeed, no degree of mathematical accuracy in ascertaining the moon's position can be attained.

Of these I shall only mention a very few, and those the most common, and familiar, and important—not discussing them mathematically, which is not the object of this little work, but popularly and practically, with reference chiefly to the effect produced, and the design apparent in it.

A reviewal, then, of the system included in the lunar orbit reveals the great Newtonian law of gravitation in full and active working, by an extraordinary system of perturbation and mutual attraction between the three bodies in question—viz., the sun, earth, and moon, which, for simplicity and sublimity in results, is incomparable; while for complicity of detail, it might be compared to the most intricate piece of machinery—the moving power of which, instead of steam, with its hundred wheels, and cogs, and springs, consisted of various magnets, placed in different parts of the works, whose dial told off with mathematical precision, not the hour, but the month; so in like manner the silvery dial of our lunar clock reads off for us in the blue sky above, by just such a perfectly arranged system of attraction and gravitating machinery, every month that passes; but comparatively few, indeed, are aware that anything of the kind is necessary in order to bring this about, and fewer still, if they were, could comprehend it fully.

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* Note G.

But with reference to the ordinary phenomena of the moon with which all are familiar, the real motion of the moon in space may be classed among the first. When we look at her in the heavens, she seems to be travelling rapidly from east to west. This is a deception; her movement is exactly the opposite way; and instead of travelling, as the sun seems to do, from east to west, she is travelling along at 2000 miles an hour from west to east—yes; it is only the huge old weary earth, as it lurches round on its axis from west to east, that overtakes her in the heavens, and as it whirls each point of its surface past her, makes her seem to rise in the east and set in the west. This is easily proved by watching the moon, with reference to the stars in her neighbourhood. Some fine evening when you are thinking of anything else, perhaps, you raise your eyes, and, suddenly you perceive a pale and slender silvery crescent in the west, just as the sun is going down—it is the new moon. But which way is she voyaging? She has just shewed her pale face over the western horizon, from which she is hurrying as fast as she can speed; but all in vain, the earth, ponderous as it is, is too quick for her. In a little time she is overtaken by our western horizon, into which she drops like a snowflake, *with the stars among which she seems located,* and we see no more of her for that night. But now watch again the second night; there she is still, and something larger—the bright side towards the sun and the west, her horns turned to the east, but she is further from the west than the night before. But *where are her neighbours, the stars, among which she was?* They are some way behind her. On sweeps the dark line of the earth's horizon as before; down go her glittering companions of the former night, but she is not among them now—she is not yet gone herself; they have plunged into the horizon before her, and she has gained that much on her pursuer; but still on it rolls, and now once more she is gone for the night—and so it proceeds. The next night our fickle luminary has left the stars, in whose company she was last night, and looks for new acquaintances in the east, towards which she is hurrying on her way rapidly till overtaken by her pursuing enemy behind her; at last, however, she has gained the victory apparently. To-night she has absolutely reached the eastern horizon, nay, she has got below it, and now two horizons must sweep past her—the first to make her rise in beauty in the east, the second to make her set in glory in the west. But still she pursues her unseen path below the east. Later and later she rises every night; at length we see her no more, except at sunrise in the morning, as a slender crescent—and now even this fades and disappears, swallowed up in the solar glory, till, in a day or two, on raising our eyes to the heavens, there, in the west, the same pale, lovely, silvery object meets our gaze in precisely the same position as we saw her at first. And what does she say to us?—Since last you saw me here, a month has rolled away.

But while this has been going on, many changes have taken place in the appearance of our satellite. Starting from her conjunction with the sun, until she returns to him again in her progress through the intermediate points, or at quadratures, as they are called, the illuminated part varies according to her position. No figure on paper can convey to the mind so well the nature and cause of these changes as passing an apple or a small globe of plaster of Paris* round a candle, when every phase, or change of the moon, will be exhibited to perfection.

These phases, or different appearances of the moon, have been used in popular language to designate what is called the moon's age, or her quarters, as they are set forth in the almanacs; the orbit she describes round the earth being supposed to be a circle of 360°, divided into equal arcs of 90° each. When she has completed the first 90° from conjunction with the sun, she is in her first quarter, as it is termed, and presents herself as a half moon.

The next stage of her journey brings her into opposition on the opposite side of the heavens from the sun, when she is full; from that point, having now got to the westward of the sun, she begins to decline, with her horns reversed, and the light upon the opposite hemisphere, till having reached her declining quadrature, where she is again a half moon, she at length dwindles as before to a thin crescent, seen at sunrise, and at length disappears altogether for about three days, while she is in actual conjunction.

These phases of the moon have been popularly supposed from time immemorial to affect the weather upon earth. It is a question, however, which seems still to remain in obscurity; for although there is nothing at first sight to lead to the supposition that the moon having moved 90° further in her course, which is all that these changes indicate, should produce corresponding changes in our atmosphere—and the experience of Arago, from observations carried on for many years for the purpose of ascertaining it, does not bear out the popular opinion *in the way it is usually held*—yet certain facts have been collected from observation, sufficient to shew that it is far from certain that the moon exercises *no* influence upon the terrestrial atmosphere according to the position in which she is with reference to her primary. It is curious enough, indeed, that the result of the evidence which has been collected upon the subject seems to be contrary to the prevailing notions. For instance, it has been found that there is generally more rain during the increase than during the decline of the moon; and the new moon, which is popularly looked to as a kind of index to the weather, has been found by actual observation to be apparently less active, with reference to change, than any of the other phases. It has been found likewise that rain and foul weather are more frequent during the moon's perigee—*i.e.*, when she is nearest to the earth, than when she is in apogee—at her greatest distance. But, after all, why may not that body, which we know affects our waters so powerfully, affect likewise our atmosphere, and consequently our weather—either indirectly through the tides, which, under lunar influence, rolling in a huge wave over the surface of our globe, unquestionably cause atmospheric disturbance, or *directly*, by attractive, and electrical, and magnetic influence, now known to be the same thing, and whose powers we find so largely distributed through our atmosphere, that it ought to excite but little wonder at any disturbance that may be created by the approach or relative position of so large a magnet as our satellite?*

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* A globe of plaster of Paris may be made, of two or three inches of diameter (in a few minutes), by turning round rapidly a piece of wire, to represent the axis, upon which a piece of tow has been put, to which the plaster is added gradually till it attains the form of a sphere; the white of the plaster then represents the lunar phases, more like nature.

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* No one who has directed his attention to this subject will have failed to remark, how closely connected the rising and falling of the wind is with the ebb and flow of the tide. The writer had occasion to notice the cessation of the terrific storm on Christmas Eve, 1852, precisely at the turning of the tide. A similar occurrence, as well as he recollects, took place in Jannary 1839, and having frequently directed his attention to the same phenomenon, he has seldom found it to fail; it is well known by sailors and fishermen on the coasts.

CHAPTER VI.

Lunar Distances—Her Mass and Density—Orbit—Periods—Axial Rotation—Gravity on her Surface—Effect upon Oceanic Tides—Balancing in Space—Irregularities—Extraordinary Calculations—Astronomical Tables—Beautiful Apportioning of her Light.

The distance of the moon from the earth, reckoning to the centre of the latter, is 240,000 miles, or, to speak more correctly, her mean distance is 238,650 miles—for her orbit being an ellipse, and not a circle, her distance varies considerably; producing a difference in her proximity or remoteness to us of 26,000 miles. When she is nearest, she is said to be in perigee; when most distant, in apogee. This distance, although considerable in terrestrial measurements, is absolutely nothing in space, but yet sufficient to produce a sensible difference in the apparent size of her disc, causing her to vary from 33′-32″ to 28′-48″ which is the minimum. The most recent and exact measurement of her real diameter, as measured by Dr. Wickman, makes her 2162 miles; and from this measurement Mr. Hind assumes the bulk of the moon to be to that of the earth as one to forty-nine—*i. e.*, our globe is equal in magnitude to forty-nine moons; while, according to the same calculation, it would require a million and a half of such bodies to equal the sun.

The moon performs her journey round the earth (roughly speaking) in a month, but there are no less than five ways of reckoning her revolution known among astronomers. Of these the most common and important are two, which are called her *sidereal* and her *synodical*, or lunar month. The sidereal is her revolution in the heavens, reckoned from a star till she returns to the same star. This is performed in 27 days, 7 hours, 43 minutes. The *lunar* or *synodic* month, with which we are more familiar, is her revolution as it is reckoned from one conjunction with the sun to another. This comprises a period of 29 days, 12 hours, 44 minutes, 2·87″—a longer period than the other. The cause of this difference is to be found in the fact of the moon's motion in space along with the earth; so that, starting from the sun, when she returns to him again in her orbit round us, she will have moved past him, along with the earth, in the meantime; or viewing the matter *apparently*, the sun will have moved away from her, and gained upon her in the course, while she is going round us. So that, when she returns to the spot in space from which she started, she will not find the sun there where she left him, but will take more than two days to overtake him in his apparent motion in the ecliptic, which motion, however (it must be borne in mind), is really produced by herself, and not by the sun, which, to all his secondaries, is immovable.

But the great peculiarity in the motion of the moon (and indeed in all the satellites, it is now believed) is her revolution on her own axis. This differs from that of her primary, in the circumstance that her revolution on her axis is performed in the same time that she takes to revolve round the earth—in other words, her axial rotation and orbitual revolution are nearly synchronical. The effect of this is, to cause the moon always to present the same face to the earth while she turns slowly on her own axis, presenting, however, every part of her surface successively to the sun. That this is the consequence of such a motion, can be illustrated by letting a lamp or a candle on a round table represent the sun; let one person, whom we shall call E, represent the earth. Let E stand at a sufficient distance from the table to enable another person, whom we shall call M, to personate the moon. Let M then walk round E, keeping his face constantly and politely towards him, and it will be found that M will have successively presented every part of his person to the lamp, thereby proving that he has revolved completely on his axis. The effect of this motion theoretically is to maintain the stability of the system; but, practically, it produces a curious effect upon the moon's periods and seasons, which separate her in analogy altogether from her primary; it is to make the lunar days and nights equal to fourteen of our days and nights—to cause on the hemisphere, facing the earth, fourteen alternate days of sunlight and earthlight (or moonlight caused by the earth), and, on the opposite hemisphere, similar periods of daylight and starlight. In fact, were there inhabitants on the opposite hemisphere of the moon, they would never know of our existence, except they travelled to the horizon next us, when they would see the strange sight of a huge globe right over their head, turning slowly and perceptibly on its axis, and presenting successively, when not obscured by clouds, each feature of mountain, island, and continent.

This journey could easily be accomplished indeed by lunar inhabitants, as owing to the diminution of gravity upon her surface, muscular power would be increased sixfold, and a man could walk ten miles an hour with perfect ease to himself, being enabled even to keep up with the rotation of the moon on her axis, so as to live in perpetual sunshine.

But, perhaps, one of the most useful and wonderful arrangements of the moon's position and orbit, is that by which she is a regulator of the oceanic tides of the earth. This subject, it is true, in its detail, rather relates to a consideration of the phenomena of our own planet—and, indeed, is so extensive, as well as interesting, as to deserve a separate treatise; it is, therefore, only referred to here as one of the *many* good offices performed for us by our beautiful attendant, that shew a supervision and ordinance of Infinite wisdom for our advantage. Suffice it to say, then, that it is to the moon's influence chiefly that we owe the regulation of the oceanic tides—a matter of such vast importance to us; and that at new and full moon, our satellite acts in conjunction with the sun, by their united attraction (in which, however, the solar influence is but slight, comparatively), to draw up the oceanic waters from the earth on the *side* presented to these luminaries; while, at the same time, they *draw away the earth* from *the waters* on the *opposite hemisphere* (the earth being nearer to them than her waters on that side, and, consequently, subject to stronger attraction). The effect of this is, to create a huge tidal wave on the opposite sides of the earth, viz., that *next* the moon and the sun, and that opposite to them: the first caused by their attracting the waters; the second, by their attracting the earth. The effect upon the other two sides or hemispheres of the earth is, to decrease the amount of water, or to draw it away; so, that while it is high water at the two first-named hemispheres, it is low water at the others. But this is not all; the moon acts independently, and when she is in *quadrature*, or half-way in her orbit between the sun and earth, her attraction operates in opposition to the sun, and the counteracting attraction of the two bodies moderates the effect of the tides all over the globe—producing what is called neap or low tides. This is a mere barren statement of the great principle by which the tides are regulated by the moon—simple enough to understand in its general features, but when examined and analyzed, one of the most difficult problems in astronomy to solve. Indeed, it requires geographical as well as other knowledge to a great amount to arrive at it; for the effects of wind, and local tides and streams, must be calculated, involving a perfect network of cause and effect to be unravelled before arriving at precision; but, when arrived at, as it has been, it presents a perfect whole, shewing in every part the clear steps of the Divine skill and wisdom for our benefit.

A glance at the ordinary and less complicated balancings of the moon in her journey will conclude this branch of the subject; and here the progress of our satellite around us may be compared to the course of a good man, pursuing his way against opposing difficulties and obstacles—now drawn aside by this influence; now retarded by that; now urged more swiftly on his way; now deviating a little from his course, but to regain it again; now letting his light shine before men, and now withdrawing it from their view, but still pressing on in the course prescribed: each phase of increasing brightness representing beautifully that path of the just, that shineth more and more brightly unto the perfect day. Or the sun, the earth, and the moon may be compared to a family, of different dispositions, and tempers, and pursuits, who, being of one mind in heavenly matters, have agreed to correct each other's faults mutually, when they are going astray—bringing each peculiar quality, which would counteract the opposite, to bear upon each other through life; and so to run their course that, although to a superficial observer they might, occasionally, appear to be discordant, or to differ in opinion, all would, in reality, be perfect harmony and peace between them. So it is with our satellite in her orbit. Wherever she goes, she meets with some influence at work to hasten or retard her in her onward progress—to make her deviate, or return to her former position—in fact, perturbations or disturbances from her companion orbs are on every side of her, and continually operating upon her by their attraction. Yet still she continues on, notwithstanding all, no real or serious deviation occurring—nay, more, all is foreseen, foreknown, pre-determined, and planned in the Divine mind that created her so accurately that, although no iron track marks the road in the viewless æther through which she passes, no foaming wake is left to shew her rapid progress, yet it can be traced and measured to a hair's breadth in all its irregularities; nay, with such precision does she move in the course appointed, as to put to shame and fault the finest instruments that human art and science can invent for ascertaining her position, and makes the most skilful and delicate contrivances—even the very spider's web—seem coarse and insufficient; but from the apparent irregularities of her movements, the most perfect law and regularity can be deduced, and the most complete order discovered, ascending in a regular scale, that it may descend again to where it set out. And so it is with all the heavenly bodies; a series of perturbations are established between them all, of which it is hard to say which is the most wonderful—the apparent disorder of the disturbance, or the perfect harmony that is the result. But let us look at this matter a little closer.

The moon, although the humble servant of the earth, and apparently under her sole influence, yet acknowledges a superior authority in the sun, to which she is subject in common with her primary, and by whose attraction she is retained in her orbit, independently of her, so that if the earth were annihilated, she would still continue to circulate round him as the earth does. This kind of solar influence is common to both planets, and is exerted equally upon them; but the law of gravitation has been so beautifully devised and arranged by the Almighty, that the solar influence is likewise exerted *unequally* upon both bodies according to their relative position—the sun sometimes drawing the moon to himself away from the earth, and sometimes drawing the earth away from the moon—in the former case, when the moon is nearer to him than the earth; in the latter, when the earth is nearer to him than the moon. This result is owing to the celebrated Newtonian law, that in the case of two bodies attracting each other, the power of gravitation increases or decreases in intensity inversely as the square of the distance—that is to say, it gains power (in this proportion) as they approach each other, and loses it as they separate; consequently, when the moon is in conjunction, or at the same side of the heavens as the sun, she is more powerfully attracted towards him than the earth, and (if not prevented by terrestrial gravitation or attraction, as well as the exquisitely proportioned and adjusted initial velocity, given her when she first rolled from the

Creator's hand) would finally abandon the earth, and (in a little more than two months) descend to the sun, to sink like a millstone in his fiery mass.

In like manner, when in opposition, she would (from the same cause) either flee away altogether from us, never to return, or, in five days, rush down upon our heads, and crash, in thunder and ruin, upon our surface. The present arrangement of the law of gravitation, however, is such as to render either catastrophe (so long as that law subsists) impossible; that it ever should have been made at all, indeed, La Place has calculated as being, in the ratio of chances, as eight thousand to one against it; plainly shewing thereby the intelligent design of Beneficence towards us. But, so it is, that just in proportion as the solar attraction acts partially upon either body, the mutual attraction they have one to another is diminished; and, *vice versa*, in proportion as his influence is diminished on either, their mutual attraction to each other is increased; just as we might suppose the attachment of two people for each other to be diminished or modified by the presence or absence of a third; or (to use another illustration), in proportion as the *direct* authority of the Queen was exercised or withheld in Ireland, the influence of the Viceroy would be diminished or increased accordingly. But the first great effect of solar perturbation on the moon is to make her orbit an ellipse, or oval, instead of a circle. The longer axis of this ellipse revolves slowly, but continually, and is called the rotation of her aspides, or points of her orbitual axis, which perform their complete revolution in about eight years, during which her apogee and perigee, *i. e.*, her nearest and furthest distance from the earth, change places.

But, looking at the moon under the solar disturbance, we may imagine her as labouring up hill *from* conjunction with the sun, and down hill from opposition to conjunction; for the attraction of the sun over the moon is always two and one-fifth times more than that of the earth over her.

But how, it may be asked are the catastrophes we have already referred to to be prevented? Just by the beautiful adjustment and balancing of the three bodies in question mutually attracting and counterpoising each other, according to their position and mass. Thus:—It is the golden rule of the great Newtonian law, that in the case of a body revolving in its orbit, under the influence of the two forces of projection and gravity, supposing the projectile force to remain the same, whatever tends to diminish the force of gravity causes the body to recede from the centre, and to approach the tangent of its orbit; and, of course, whatever increases the force of gravity causes it to approach the centre. Now, when the moon is in conjunction with the sun, the earth acts as a counterpoise on the opposite side, thus diminishing the solar gravity, and, according to the law we have mentioned, causing her to recede towards the tangent of her orbit, thereby preventing her from abandoning us and rushing into the sun, while, at the same time, her velocity being too great to enable her to set up an independent orbit for herself round the great luminary, she recedes gracefully from him, and continues her course round us. On arriving at her ascending quadrature (90° further), where she is side by side, as it were, with the earth in reference to solar distance, the attraction of the sun will act equally upon both, being at the same distance from him, so that were the projectile force removed, both bodies starting together would arive at the same moment at the sun, while being acted upon equally by him, their mutual attraction would not be disturbed, and they would approach each other on the way; but the moon, having thus arrived at quadrature, and receded considerably from the sun, the solar gravity has diminished, while the terrestrial gravity has increased. Accordingly, continuing her course round the earth, she is shortly in opposition, and the earth now lies between her and the sun; the gravity of the latter, however, having been lessened considerably by her distance from him, while, on the other hand, the power of the earth's attraction is greatly increased by the same law; the joint efforts of both sun and earth here conspire to hold our beauteous companion in her place, and make her submissive to their power. She, accordingly, instead of taking her leave of us, turns kindly round, and smilingly descends to her falling quadrature and conjunction, again to perform her appointed task, as though endued with life and intelligence, and that the words of Scripture respecting the sun were literally true of the moon—viz., she knoweth her going down.

But, besides these ordinary motions in space, there are numerous irregularities, already referred to, all of which must be taken into consideration in ascertaining the moon's place in the heavens with precision. Some of these are real, and some apparent—*i.e.*, not arising from the moon's motion, but from ours combined with hers. Some are so delicate as to be scarcely perceptible; others plain enough to be observed; but one and all present a perfect agreement of theory with experience and observation—the discovery of them sometimes originating with the observation, and sometimes with the theory, but presenting so wonderful and beautiful an entire, that the mind is lost in wonder and admiration at contemplating it. Of these, of which there are sixty now ascertained, leaving indeed nothing more to be discovered, and affording the most perfect astronomical tables for lunar observations that could be presented to the mind of man, it would be impossible and, indeed, useless to speak, in a treatise like this; I shall, therefore, only remark upon one or two striking effects, of great importance to our comfort and convenience, which are calculated to shew the design of Infinite wisdom and benevolence towards us in reference to utility. Passing by, then, her librations in latitude and longitude, by the former of which she seems to swing round on her polar axis, so as to shew a portion of her eastern and western hemisphere, not always visible; and by the latter of which she seems to vibrate, or balance to and fro on her equatorial axis, so as to present alternately a portion of her poles not usually in view;—passing by these, the former of which is caused by her motion on her axis being a *little* faster or slower than her revolution, and the latter by the angle at which she is inclined to the earth, we may remark, that according to the movements we have already described, the new moon will always be found in the same part of the heavens with the sun, and the full moon in the opposite part. So that, as a general rule, it may be remembered that the full moon rises and the new moon always sets at sunset. But the consequence of this arrangement to us is of the greatest importance, for in winter the sun, being in the winter solstice, sets far in the south-west, running very low, and, accordingly, the new moon, that must always bear him company, runs low too; but, for the same reason, the full moon, rising in the opposite side of the heavens, far to the north-east, runs high, as we may remember, in the middle of winter; but, in summer, the case is exactly reversed. The sun runs high, and so do the new moons—but the full moons low. The consequence of all this to us is, that we have the greatest abundance of moonlight when we need it the most, in the depth of winter, through whose long evenings and dreary nights she remains to enlighten and cheer us; while, on the other hand, we have less of her light when we require it least—*i.e.*, in summer, when we have most of sunlight, when the full moon appears but a short time above the horizon, and there is no real night, the sun's last red rays scarcely fading in the west ere they are resumed in the east. But the effect of this arrangement is peculiarly valuable to northern nations, and the inhabitants of the polar regions. There, as we know, they have constant day for many months, and night for a similar period; but, for the same reasons that we have mentioned, no sooner has the sun taken his leave of them than the moon takes his place, and remains constantly upon their horizon during her second and third quarter, when she is brightest and largest; while in summer, when the sun is constantly above the horizon, and lunar light is not needed, she is only in view during her first and last quarter, when she is a mere crescent; but it is only to the polar region she is such. At the same moment a full moon is lighting up with her splendour those regions of the earth from which the sun is absent.

CHAPTER VII.

Fresh Proofs of Intelligent Design—Benevolent Intention—Harvest Moon—Paley on Astronomy, as a Medium for Proving Divine Agency—Comparison with Anatomy and Geology—Lunar Arrangements—Proofs of God's Love to Man.

Now, what are we to think of all this? Is it by chance that it so fell out? and is it only by a happy concurrence of fortuitous atoms that the complicated but beautiful machinery we have described, and the wondrous movements of our satellite, first fell into their present shape and arrangement; and that order, and beauty, and utility thus sprung from disorder, and ruin, and hideous chaos; and light was portioned out successively to every part of our globe, according to its need, with unfailing punctuality, and unerring precision, and provident calculation? Let the sceptic and the materialist ponder upon this, and think if his creed can stand a moment before such a supposition, before the solemn testimony of our satellite against him; let him endeavour to design a machine which shall imitate, ever so imperfectly, the lunar movements in all their parts, and produce the various effects we have mentioned, and he will, even with nature's model before him, find how it will tax his skill and ingenuity to the utmost; but *without* that model, could he have executed or even imagined it? But that blind chance or necessity could have originated such wondrous laws is the last reach of human folly and human presumption to affirm. As rational, indeed, upon such reasoning, would it be to say, that if a son asked his father for bread, it was by chance he did not get a stone; if he asked for a fish, it was by chance he did not get a serpent: for in such a theory there can be no rational connection between cause and effect—and one might as well happen as another. But in the simple view which Christianity reveals, the very reverse is the fact, and there is no chance at all about it. An intelligent, infinitely wise, and gracious Father is revealed as the solution of the problem—presiding over all, and providing for all according to their need. "Your Heavenly Father," says Jesus, "*knoweth what ye have need of.*" And again—"If ye, being evil, *know how* to give good gifts unto your children, *how much more* doth your Heavenly Father *know how* to give *good things* to them that ask him." In this case, indeed, God waits not to be asked—His provident love and kindness have arranged it beforehand. He maketh His sun (and may we not add His moon?) to shine upon the just and upon the unjust—alike the witnesses of the power which has created them, and the wisdom and love that has devised them.

But there is one more beautiful effect, which we must notice—viz., the harvest moon. About the period of the autumnal equinox, any one may remark what a number of bright moonlight evenings we have. These are called, popularly, harvest-moons, because they occur at the time when the harvest is getting in, and her prolonged light is peculiarly seasonable, enabling the labourer to devote extra time to this uncertain but needful work after sunset, and thus secure the crops. Whether this was really the intention of this arrangement, it is impossible to say; but certainly it has been so popularly remarked and adopted by most nations,* who from their position on the earth can derive benefit from it.

The following lines of Henry Kirke White contain a beautiful description of a moonlit harvest scene:—

> "Moon of harvest, herald mild
> Of plenty, rustic labour's child,
> Hail! oh, hail! I greet thy beam,
> As soft it trembles o'er the stream,
> And gilds the straw-thatch'd hamlet wide,
> Where Innocence and Peace reside;
> 'Tis thou that glad'st with joy the rustic throng,
> Promptest the tripping dance, the exhilarating song.
>
> "Moon of harvest, I do love
> O'er the uplands now to rove,
> While thy modest ray serene
> Gilds the wide surrounding scene;
> And to watch thee riding high
> In the blue vault of the sky,
> Where no thin vapour intercepts thy ray,
> But in unclouded majesty thou walkest on thy way."

The astronomical cause of this is plain enough, though, perhaps, not so easily explained popularly as other of the lunar motions. It arises from the small angle formed by the moon's path (or the ecliptic, which is nearly the same), at that particular period of the year, with the horizon—the consequence of which is, that the moon has not time to get far below the horizon, and rises for three nights successively before and after "the full" about the same hour—or, at least, not more than twenty minutes later each night. It is true that the very same phenomenon takes place every time the moon is in Pisces or Aries—viz., once a month; but it is only at harvest time that it happens when she has a full face, and consequently becomes an object of notice.

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* This would not apply to nations in the neighbourhood of the equator.

And now, may we not ask, putting aside altogether as unworthy of notice or argument, that ungrateful perversion of mind, called Atheism, which makes the "fool in his heart" say "There is no God"—may we not safely say, is there not evidence here in the wonderful machinery of the heavens for the most cavilling mind to ponder upon—for the most sceptical to be awakened by—and, we may add, is there not reason for the unfeigned admiration and praise of the Christian? It has been said by Dr. Paley, that "astronomy is not the best medium through which to prove the agency of an Intelligent Creator." This, he says, arises from our want of knowledge of the constitution of the heavenly bodies—both as to their forms and motions—which are not sufficiently known or evident as to be at once apparent to the mind, and to render them adapted, as some other subjects are, to the purpose of argument. This may be the case to a certain extent; since the days of that eminent man, however, our knowledge of the heavenly bodies has greatly increased: and, if it be not the *best* medium, it is certainly not the *worst*—for astronomy stands in a very different position, and that which was confined to a few has now become the property of the many. This difficulty is, therefore, considerably obviated, and, at all events, in the case of the moon and the lunar motions, it may be considered as completely removed; for what machine is there, with which we are better acquainted, or that can be more accurately described, than the wondrous machinery of the lunar motions, although carried on, it is true, without any sensible intermediate apparatus? This, indeed, is unnecessary for the purpose, provided the adaptation of the means to the end can be perceived; and the knowledge of the Newtonian law is quite sufficient to do this—to develop every movement, and lay bare every working of the heavenly engine. "Once convinced," says Dr. Paley, "of the agency of an Intelligent Creator in those movements, and astronomy raises the mind to sublimer views of the Deity than any other subject affords." The intellectual agency which it does reveal, he divides into three—viz., "*choosing, determining*, and *regulating. Choosing* out of a boundless variety of suppositions, which were equally possible, that which is beneficial; in *determining* what, left to itself, had a thousand chances against conveniency for one in its favour; in *regulating* subjects, as to quality and degree, which by their nature were unlimited with respect to either." Instances of each of these, we trust, have been given in the foregoing short and superficial treatise upon the constitution and movements of our satellite. But we do not ourselves think that there is any science which affords *more* striking proofs, not only of Design and Intelligence in the Creator, but of the existence of those peculiar and more endearing attributes by which we are accustomed to know Him, not only as the God of Nature, but the God of Revelation: not only as God in His works, but God in his word. Nor do we think that the proofs are less accessible because of the distance and the magnitude of the bodies of the system which is the subject of our study. Indeed, the works of God are all nearly on an equality in this respect—they all need to be examined. Thus the anatomist holds the mirror of science to himself, and he finds a wonderful system within him: a mighty engine or forcing pump, whose every throb he is momentarily conscious of, but of the nature of which he is ignorant until he examines, and then he finds a labyrinth of rivers and streamlets, whose red and purple currents are propelled with wonderful energy and force through the entire body; he finds a number of valves that open and shut exactly where they should, and at the precise time that they ought; he finds a number of beautiful contrivances, in which the skill and ingenuity of the maker are apparent as in the works of a watch—difficulties met and overcome—natural obstacles occurring to be vanquished; and all with a wisdom that is never set at nought, with a beneficent intention which cannot be mistaken. He finds a number of thread-like fibres, interwoven one with another in apparent confusion to the inexperienced eye, but in real and perfect order, conveying every message as well as sensation along them to and from the mind's audience-chamber with the rapidity of light, like the electric wires that can now conduct human thoughts over land and under sea, to the extremities of the globe, on the lightning's wing. He finds these—matter themselves—connected mysteriously with the thing called mind or spirit, which is invisible, save by its effects; and the result of all is, to impress the unprejudiced mind with the firm conviction of design, and skill, and wisdom, and benevolence, without limit. But if thus the anatomist examines the body, and the astronomer the heavens, the geologist moves earth to make out his case; he stirs up the ground beneath him, and searches in its bowels, where he finds as evident records of design in its creation. But so long are the periods that have passed away since its commencement, that he stands amazed, and the hoary earth, for a moment, assumes the garment of eternity—but it is only for a moment: there is a limit even to these periods, long as they have been; nay, there is a commencement of them all, far as he must go back for it, even beyond the powers of his imagination to conceive. In each of the terrestrial strata will be found a great variety of creation, but each confined to its own period, and never intruding upon another—in short, the same order and succession of organic life that may be perceived in a cabinet or museum arranged by human intelligence, and placed in their proper positions by human hands, from the first specimen that is put there to the last. Thus, the very same perfect order and arrangement, but of a different kind, may be discovered here, that is perceptible in the heavens, only in geology (with the exception of volcanic action, respecting which little is known) all is dead, and cold, and motionless, and lifeless as a statue—like the petrified city or forest in the Arabian tale, or like an engine that had performed its task, whose energy had ceased, whose wheels were silent, and whose works were cold.

In this respect, indeed, astronomy is even a more striking evidence—for there, among the bright spheres above, all is activity and motion. Some of that activity is even perceptible to the naked eye, and comes under popular observation, as also the perfect order with which it is conducted; but when examined closely, as it may be, as a witness for its Maker, we do not think it can be excelled by any other branch of natural science. In truth, none of the wonderful works of God would seem to be sufficient witnesses of His glory to sinful man, any more than His word, until examined and summoned to the testimony;—the careless eye and irreligious mind perceive nothing—the observant and enlightened, all things. "The works of the Lord are (indeed) great," but they must be "sought out by those that fear Him" before they can be witnesses of His majesty; but when once found in any department of nature, there are few sensations perhaps so delightful, and few employments more profitable than the discovery of each fresh impression of the Creator's hand, or the following up each vestige or footstep of His glory.

But how apparent is His love in the whole lunar scheme! That the entire constitution, as well as every movement of our satellite, had a direct reference to us, to *our* benefit, to *our* comfort, and *our* delight, cannot for a moment be questioned; and how wonderful the thought that, in the creation of such huge masses of matter, as well as in their position and arrangement in the heavens, God had respect to the little creature that moves upon the surface of one of them, not so big proportionally by the thousandth part (when compared to his habitation) as the grain of dust is to the globe upon which it lies! Yet, small as he is, and apparently insignificant, the formation of two planets, with their stupendous primary, had a reference to the movement of an arm or a leg in this minute creature; for were the density of the earth altered, or the force of gravity in any of the three bodies increased or diminished—in fact, were they anything else than what they are, the most strange or disastrous consequences would ensue, and we should be rooted to the ground, unable to move hand or foot, or open an eye, if not crushed to the earth; or we should be in danger, if once off the ground, of never returning again; or, were the attractive power of the moon increased, either by size or proximity, a vast tidal wave would be raised higher than the loftiest mountains, to return in a thundering avalanche of water, and roll as a fearful deluge over the entire globe. But now, her density and mass accurately weighed, and calculated, and proportioned to her two primaries; her distance measured to a hand's breadth; her position and place in the heavens balanced, and poised, and adjusted, as in a scale; and her course marked out in baseless ether, as no human hand could do on solid ground—her mass and density do their task, and no more: every arm is free, every muscle unimpeded;—her position and course in the heavens do *their* part likewise, bringing continually scenes of changing beauty and variety—while the entire arrangement speaks peace and safety to us; tides ebb and flow with clock-work regularity, and gently break on silvery strands, or roar in thunder against the craggy rock, or dash in surf upon the pebbly beach, but their mark is alike determined—their line is measured out—and the command of God has gone forth, conveyed and executed by the bright mass of our attendant planet, that, smiling calmly down from her seat on high upon the midnight wave, as though she were an unconcerned spectator, is all the while saying—"Thus far shalt thou come, and no farther." But even the configuration and appearance of the moon testifies the same—that which renders her unfit for a human habitation herself, makes her minister the more to human comfort and delight. Were she a polished mirror, with a perfectly smooth surface, instead of being perforated and rugged with mountains as she is, and spread over with rough inequalities, the light she gives, instead of being extended over her surface, would be confined to one bright part, round which all the rest would be comparatively dark, as the reflection of a candle in a looking-glass or in water; but now, in consequence of her inequalities, the entire surface is resplendent. Again, had she an atmosphere like our own, and obscured as frequently with clouds as ours, how often would she be invisible when our sky was clear, or rather how seldom would she be visible at all —now hidden from mortal view by *our* clouds, and now by *her own;* but as it is arranged, her full face is unchangeable as it is lovely.

CHAPTER VIII.

Beauty of our Satellite—Impression produced by it—Worship of the Moon—Idolatry—Insufficiency of its removal by Philosophy and Science—Study of the Word and Works of God—Natural and Revealed Religion one Science—Superior Importance of Revealed Religion—Value of the Soul—Human Greatness—Powers of the Human Mind—Love of God to Man—The Two Witnesses—The New Heaven and the New Earth—Astronomy as a Study—Man ισαγγελος—Man's final Home.

Few, perhaps, attach much importance to the quality the moon possesses of exciting admiration, or the impression she produces by her beauty, and yet it is worth noticing. If we enter a flower-garden, where colours and tints of every hue and shade of loveliness meet our view, the intention is at once apparent. Whence this array of beauty and variety, if not for man's eye?—the lower animals heed it not. If we look at a lovely landscape, it is the same. Whence all this wondrous arrangement of light and shade, of smiling valley and purple mountain—of wood and rock, and stream and river, and lake and meadow green, producing such a perfect combination of beauty, if not for man?

So we may say of our satellite, which, it must be acknowledged, possesses to perfection that quality which seems to belong to nature, but not to art—of never tiring by repetition. At once the constant theme of the poet's song, and the subject of the painter's study, and the object of our continued observation from our childhood, it is never out of place as an object of admiration, or interest, or striking effect; it never palls upon the taste or wearies to the eye, but presents itself each time in some new aspect of beauty.

Let us recall to our mind any of the calm moonlight scenes with which the memory is stored, and we shall find this to be true; or watch the next opportunity when it may be realized. Stand upon the deck of the lone ship on the wide ocean—see the moon rise majestically, as a vast globe of fire, from her bed, and turn first to gold and then pale to silver, as she mounts on her way; or float, on a summer evening, on the bosom of a mountain lake, and see her climb the heavens visibly, as though she walked along the dark brow of that heathery mountain, until she disappears behind the rugged cliff at the summit, while a silvery, hazy twilight is shed around—now trembling on the rippling water, now dropping like diamonds from the glistening oar; now bathing in its pale beams each rugged feature of the peaceful scene, while the deep, dark shadow lies, all the while, like a giant slumbering under the great mountain's breast. Or, walk through the green forest glades of Old England by moonlight, when her broken beams come gleaming through the leaves and shadowy boughs, in a thousand fantastic shapes and bright patches, upon the calm green sward beneath, or illumine the trunk of that old gnarled oak, or the white bark of the birch. See her trembling upon the calm river or streamlet; or flashing back from the diamond panes of that quaint old church-tower, lighting up with ghostly splendour the marble monuments of the great within, or pouring a flood of peaceful light upon the quiet, green graves of the poor without. See her in midwinter, shining down from the lofty zenith over a white waste of snow, and sparkling upon the frost-spangled leaves that glitter in her beams. Call up all these scenes successively to the memory, or seek them afresh in nature—let them be repeated ten thousand times, and each time ten thousand new beauties will meet the view. Yes, there is a calm loveliness and quietude about her light, that soothes the mind; there is a tender solemnity in her clear, yet mysterious beams that, viewed in the hour of stillness and repose, strikes on the varied chords of human feeling in a wonderful way, and accordingly the impression produced is not confined to any race or country—to any age or clime—from the group of our own merry children, who revel in her beams, shouting the well-known nursery rhyme—

> "Boys and girls, come out to play,
> The moon doth shine as bright as day,"

to the wild and untutored savage in the forest, who falls down to do her homage.

But the impression produced upon the mind untaught in the knowledge of the true God is thus alluded to by Job—"If," he says, "I beheld the sun when it shines, or *the moon walking in brightness*, and my heart hath been secretly enticed, or my mouth hath kissed my hand, this also were an iniquity to be punished by the judge, for I should have denied the God that is above."—Job xxxi. 27. The allusion here is to one of the most ancient and common forms of idolatry, proving indeed man's fatal alienation and apostasy from God—but proving not less certainly the powerful impression produced by the heavenly bodies upon the mind, so strong as to cause man to bow to *them* instead of his Maker. "Take good heed, therefore," says Moses, "lest thou lift up thine eyes unto heaven, and when thou seest the sun, and the moon, and the stars, even all the host of heaven, shouldst be *driven* (*i. e.*, compelled) to worship them and serve them, which the Lord thy God hath divided unto all nations under the whole heavens."—Deut. iv. 19. What, we may ask, then, is the legitimate effect of all the wisdom and perfection to be discovered in the movements, and the glory and beauty to be seen in the aspect of our satellite and her glittering companions? Once remove the gross film of idolatry from the eyes and mind of man, and all the full weight of the impression made ought naturally and directly to be transferred from the thing created to the Creator. Every contrivance of wisdom now apparent; every benefit and blessing conferred; every beauty impressed, should fill the swelling heart of enlightened man with an indescribable weight of gratitude and obligation, that he may return it again to the bosom of Infinite Love, from whence it proceeded.

But, alas, although this would seem to be the inevitable consequence in every case, it is far from being so in fact. It is not enough, in order to excite love to God in the heart of sinful man, that the grosser forms of idolatry should be removed; it is not enough that he should know that there is a God who has "made the heavens, and all the host of them;" it is not sufficient that he should be led to scorn the base notions that would lead him to bow to anything in heaven or in earth; it is not enough even that his philosophy should have taught him to know the constitution, and to measure out every movement of the bright spheres above, and to trace their cause and effect—to perceive the beautiful adaptation of the means to the end, and to be impressed with a deep sense of the wisdom, and skill, and power, and goodness, and love of their mighty Architect, as seen in his works. All this may be, and the mind may be exercised with glorious truth, and the brain be taxed to the utmost with abstruse calculations, and the heart and the feelings deeply agitated and excited even to the wildest enthusiasm, by the grandeur, and glory, and sublimity, and beauty of the spectacle of the heavens, and yet no real good effected by it for himself, and the heart remain unmoved, unchanged, unconverted to God. This is ever the case, when, however familiar with God's works, man is not equally familiar with His Word—when knowing God well in the former, he is not willing to know Him in the latter. The utmost attainment of astronomical knowledge, or any other branch of natural science, can but ill compensate for this serious, this fatal defect. "Look from nature up to nature's God," we may and ought; but to look up at the magnificent array that is spread before us, without previous preparation of heart, and spiritual enlightenment of mind—without the knowledge of *His* character with whom we have to do, is to set sail on a boundless ocean without rudder, compass, or chart; it is like reading a book without knowing anything of its author; or admiring an ancient building, and contemplating the beauty of its proportions and its architecture, without knowing anything respecting its architect, its origin, or its history.

But for the temporary pleasure, indeed, it may confer, or the information it may impart to the world, such unsanctified knowledge of the physical world *without*, with total ignorance of the moral and spiritual world *within*, as it is revealed in the Bible, can do but little for a man ; and even that little may prove injurious to his everlasting interests. God has given us two books to study—nature and revelation. Natural science and revealed religion, as studied by the world at large, are as two roads running parallel to each other, along which men frequently pass and repass through life, without an interchange of thought one with another; but little wonder—they can never meet until inclined to each other by some power from without—this once being done, and ever so slight an inclination given of one towards the other, by the teaching of the Word and Spirit of God, men will find themselves travelling, not along parallel lines, but the radii of a great circle, which must meet eventually, whose centre is God and His glory—Christ and His truth; and this is absolutely necessary to enable us to form a right conception of both. As time and space assume one and the same aspect under the close inspection of astronomical knowledge, so, no doubt, it will be found hereafter that natural and revealed religion will prove to be but one great science. While we are here, however, they assume a two-fold aspect; and if the study of the laws that govern the natural world is necessary in order to understand nature aright, equally necessary is the study of the laws which govern the great moral world within us, as revealed in God's Word. If, indeed, a preponderance is to be given to either, it should be to the latter; for, after all, what is man, or in what does *his* greatness consist, but in the existence of this moral world?—where is it to be found if not in his mind? When compared to the material world, he is absolutely nothing—he is annihilated by the ponderous masses around him. But there is no greatness or littleness with God in this respect; and the same care is bestowed by Him upon the tiniest bluebell that lifts its head in the forest, as upon the lofty tree under which it is blooming—upon the smallest insect that hums in the summer air, or the down upon the butterfly's wings, as upon the largest animal whose heavy tread is heard upon the globe; the muscles of the ant's legs are as carefully adjusted to the earth's gravitation, as the thigh or trunk of the elephant. Of this care and beautiful adjustment, man has his share, and no more: and, though his bodily organization is more complicated and perfect, in many things he is far inferior to the lower animals, whose senses indeed are more acute, and whose physical powers are much greater than those of their lord and master. But it is the *mind*—the *immortal* part, that makes the mighty difference—endued with the wonderful powers it possesses, and having the indestructible nature that it has, in the sight of God Himself it assumes a preciousness which no language can adequately express, and which, alas! man cannot always feel for it himself. The wisest and the best of all Philosophers, however, has thus described its exceeding value to us, when he says—"What is a man profited, if he gain the whole world, and lose his own soul? Or what shall a man give in exchange for his soul?"

"After all (says Dr. Paley), the most wonderful part of astronomy is, that man can know so much as he does." Confined as we are to the small space in which we move, who could ever dream that the atomic creatures of this globe have that within them that enables them to survey, not the spot of ground they walk upon, but the mighty universe of God—to hold, as it were, the sun in one hand and the moon in the other; and while as a grain of sand ourselves we stand upon the earth, to weigh it and its companion orbs, one against the other as in a scale—to determine their mass, and measure their mighty movements and distances, extending even to those apparently motionless bodies that sparkle like gems in the midnight sky, and whose remoteness is such, that even the mind is at fault in conceiving it perfectly, although it can compel figures to express it correctly?

All this man does with ease. But if this should elevate him in his own mind, the consideration of himself, as he is described in the Book of God, while, on the one hand, it humbles him to the dust as a sinner, on the other hand it elevates him far more—exalts him to the very throne, and presses him to the very heart of the King of kings and Lord of lords. If His works assure him of His provident care over him, His Word assures him of His tender love; of a love that knows no end, change, or decay—that is everlasting as the heaven of heavens, and infinite as the boundless universe. For him, not only was the earth prepared, and the heavens made to shine, but for him Christ died—for him a glorious immortality is prepared. Because man was precious in God's sight it was that the Lord of Glory—leaving the bosom of the Father, and that glory which he had in some far distant place in the universe, and, singling out, with the eye of mercy, this little speck of dust, lost, as we might imagine it to be, in the spangled ocean of the thousand times ten thousand worlds, brighter and larger than our own—made His way to the sinful children of Adam, to redeem at least a portion of them from their unhappy and lost condition. The voices of nature and revelation here unite; astronomy and revealed religion here combine in elucidating this wondrous truth, and break upon the mind like the morning glory of sunrise. A bright immortality rises from the ruins of our planet, presided over by the God alike of nature and of revelation.

The identity is perfect. It is the same God who ruleth all in all—the power, the wisdom, the skill in creation; the love, the mercy in redemption, all from the same source, and directed to the same end. If, then, we would read the heavens aright, we must read the Word of God aright; if we would understand the Word of God, and the redemption therein revealed, in its most enlarged and glorious view, we should sometimes study the heavens.

The day is coming, indeed, when the voices of nature and revelation will together testify and confess to each other's truth, and the glory of Him who is their common author; when the simple word in the poor man's Bible will be fulfilled, and echoed by the thunder-burst from above, which shall shake the heavens and vibrate upon earth—which shall awaken the dead from their graves, and a slumbering world from their apathy, with such a tempest of fire as shall turn the cold pale moon to crimson, and blot the stars of heaven from the sight, and convert the green face of nature to "one red."

"The heavens shall pass away," says Peter, "with a great noise, and the elements shall melt with fervent heat, and the pillars of the earth shall be dissolved."

How this catastrophe is to be effected, we cannot tell precisely; but that it will happen we cannot doubt. The Word and works of God will then conspire together—the one to proclaim His faithfulness and truth, and the other to carry into execution His will; and there is little difficulty in conceiving this.

The same power that gave the great Newtonian law can, by a very slight alteration of it, produce very serious and mighty changes—in fact, such a catastrophe as we look for. But let this pass, and these two solemn witnesses will conspire again in a happier and more glorious manner.

"We look (says Peter) for a new heaven and a new earth, in which dwelleth righteousness." How is this to be understood? The study of astronomy is considered, not without reason, to be the most sublime, next to the bible. This may be attributed not only to the lofty nature of the subject, and the elevating effect it is calculated to produce upon the mind, but from the fact, that once acquired, it is never lost. It will probably outlive this world, and endure in the mind for ever. In this respect, it may be distinguished from every other branch of knowledge of that class that treats exclusively of earthly things, and is what the Apostle calls that knowledge which shall vanish away. It seems to be one of the sad consequences of our strange position here, that all the labour and toil we may expend on the acquisition of knowledge, however valuable for this world, shall pass away with it, and, except for the training or exercising of the mind, and the developing of its powers thereby, no other benefit shall accrue from it; it shall be as though it never had been. Its object exclusively earthly, its end will have been accomplished when the earth has had its day, but it will find no entrance to heaven, for it is not needed there. This will, doubtless, apply to many useful branches of human knowledge and science; but astronomy, at all events, would seem to be an exception: it treats not of earthly, but of heavenly things—not of this world alone, but of worlds innumerable, and far beyond the confines of our planet, and relating only to *its* concerns as to a part of a greater, and a wider, and more glorious system. The category under which this science can be placed, therefore, at once enrols it among the noblest kinds of knowledge; as a theme worthy of angels' study, as it was, unquestionably, of their song.—(Job xxxviii. 7; Rev. iv. 10, 11.)

"The heavens declare the glory of God" (says David). The study of the heavens, therefore, is the study of the glory of God—this determines its character. If, then, it be permitted to man hereafter, like those bright spirits of whom we read in Holy Writ, to roam with the speed of light from world to world, from planet to planet, and from sun to sun,* astronomy is no lost science, and the time that we have given to it is no lost time, for we shall only enter upon its fuller attainment in the world to come. Here we are but permitted to see the porch of the temple; there we shall enter it, and span its starry dome, and contemplate its awful beauty; there possibly passing from the glory of one star to that of another; from one landscape of living beauty to another; from one cluster of brightness to another, we shall be permitted to measure the height, and depth, and length, and breadth, not only of God's power, but of God's love to all His creatures, and especially to his poor, fallen, sinful, but not forgotten creature, man. And as, wearied with our flight (if ever our angel's wing can tire), we bend our way homeward, and enter the bright, astral clustre in the midst of which shines our own familiar sun, whose beams had warmed our childhood, and our own starry home, where the years of our sinful probation had passed away, with what exultant joy may we point to it, changed, renewed, and purified, as it then will be, from sin and sorrow—the new heavens and the new earth, wherein dwelleth righteousness, henceforth the throne of the Son of God for ever, who, singling it out of His own wide dominions as the nucleus whereon to display His surpassing love in redemption, now sits down there as His seat and habitation for everlasting ages of joy unchanging —the same yesterday, to-day, and for ever! * Then the love He shewed to man in the darker and earlier history of this planet shall shine down upon his head in rays of blessedness and peace for evermore—a blessedness that shall be felt in every wind that blows, in every flower that blooms, in that happy paradise, where "peace shall be as a river, and righteousness as the waves of the sea;" where even the sun and moon shall be eclipsed by a more glorious and perfect light, for "the Lord shall be our light, and the everlasting God our glory."—(Isaiah xlviii. 18; lx. 19.)

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* Daniel ix.; and Note H.

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* Note I.

ON THE

HABITABILITY OF THE MOON AND PLURALITY OF WORLDS.

On once ascertaining the general likeness or analogy which one planetary body has to another, and which unquestionably the moon has to the earth, nothing was more natural than this supposition ; and certainly few subjects could be more interesting than the inquiry, whether the analogy of a globe resembling ours in shape was further carried out by a country resembling ours, and inhabitants like ourselves. Accordingly, upon this general analogy, together with a very slight and imperfect acquaintance with the physical condition of the lunar country, the moon was for many years considered a miniature earth ; and the writings of both astronomers and divines, up to a recent period, contain statements assuming it to be a fact all but proved and certain, that it contains land and water, seas and lakes, mountains and plains, exactly similar to our own, as well as a large population. That this was the religious belief of many, we have numerous instances. Thus Dr. Dwight, in his "Theology," says, in the sermon of that work upon the Starry Heavens, speaking of the moon—"It is most rationally concluded, that intelligent beings in *great multitudes* inhabit her lucid regions, being probably far better and happier than ourselves." Why this last should be, however, the doctor does not say. The following anecdote, communicated to me by the late Reverend Stanley Faber, would seem to lead to a different state of things there. A friend of his (Sir Frederick Beaufort), having occasion to write to Sir John Herschel at the Cape, asked him if he had heard of the amusing report in England, that he (Sir John) had discovered sheep, and oxen, and flying men (like the friends of Peter Wilkins) in the moon? Sir John had heard the report; but he told his friend that he had also heard an improvement upon it. A worthy American divine stated to his congregation the report referred to by Sir Frederick Beaufort, but added to it, that, in the wonderful discoveries of the present age, he lived in the expectation that he might one day have to call upon them for a subscription to buy Bibles for the poor benighted inhabitants of the moon. The idea thus suggested by this American divine does not, at all events, harmonize with that of their great Theologian upon this subject. But such ideas, true or false, were calculated to catch the imagination; while the proximity of the moon to ourselves, affording an opportunity for nearer inspection than any of the other planetary bodies, and the occasional reports of amateur astronomers with imperfect telescopes, helped to keep alive the idea, and effectually to prevent the pleasant illusion from being destroyed. I say *pleasant*, because there is no object perhaps in the universe that would be so interesting as the moon, were she inhabited by material beings, and clothed with the verdant beauty of our own planet. To look up at another strange world, to watch the varying hues of nature upon its surface, to speculate upon its natural history and selenography, as well as the condition, both physical and moral, of its inhabitants; to remark the different effects of returning seasons and climates upon its vegetation; to perceive the green of its summer fade into the dusky brown of autumn, and at length give place to the snows of winter; to gaze upon its sunny mornings and purple evenings, as her sun rises or sets amid Alpine peaks, or over grassy plains; to watch, with intense interest, the changes produced by the busy population themselves; to see the fires of their cities, and strange sails upon their waters, while the entire globe itself, floating like a ship of silver on her own ethereal ocean, speeds on her spangled course through the firmament; to look upon her, in fact, as we may fairly do, with reference to the planets (though more distant), as associated with ourselves in the grand plans and intentions of our common Maker, and the destiny that may await us—all this would have a charm for the imagination of the Poet, and instruction for the mind of the Christian or the man of science, that would be irresistible; and no Divine would want an argument, nor an Astronomer an audience, who could put forward such facts. Accordingly, we find that, though all this is in all probability true respecting the more distant orbs of our system, and could be seen by us could we be brought near enough, nothing of the kind has ever been discovered in our satellite—indeed, little more that is certain, since the day when the Florentine astronomer first directed his tiny glass to the heavens, and discovered "rivers and mountains in her spotty globe." Yet the imagination will still be at work where any degree of uncertainty exists; and the most absurd stories and exaggerated statements have been advanced, and held with that tenacity produced by the love of what is marvellous, the only effect of which is to throw discredit upon the real facts which have been elicited. The most remarkable of the astronomers who helped to fix the idea of the moon's inhabitants on the mind, were Huygens, Schrœter, Dr. Olbers, and Gruitheisen—and, though last not least, the greatest astronomer of the past age, Sir W. Herschel—who, although he did not positively affirm it, at least advocated its possibility, or even probability. Added to these, the clever and witty Fontenelle, though not himself an astronomer, contributed, by his remarkable work on "The Plurality of Worlds," not a little to keep up the popular idea, and give a tone of reality to it in the public mind. So that, up to a recent period, it was one of those things taken for granted, and would have been considered little less than heresy to have denied the fertility and habitability of the moon—opinions, however, which have lately undergone a great change in the minds of astronomers, and at the present time have but few advocates remaining, the arguments for it, indeed, appearing to become weaker, just in proportion as the means of investigation have improved.

Huygens, the first mentioned of the astronomers already referred to, advocated the habitability of the moon, in a work of his entitled "Cosmotheoros." He there takes for granted, without any argument, the existence of lunar inhabitants, and speculates upon their structure and functions. Schrœter, the great Berlin astronomer, and one of the most indefatigable observers, is little better. He maintains the existence of an atmosphere, though of great tenuity, water, and inhabitants, etc. He conjectures the existence of a great city to the north of Maurius (a spot on the moon), and of an extensive canal towards another spot, named Hyginus. He asserts that a portion of the great plain called the Mare Imbrium is "green as the Campagna;" and contends for the existence of active volcanoes, and the changes which are consequent upon such phenomena, detailing what he imagined to be the formation and subsequent disappearance of a mountain on the Mare Crisium, and the formation of another in a part of the moon called Helicon, where there had been none before. But the conjectures of this astronomer, upon which now but little dependence is placed by astronomers of the present day, armed with far superior instruments, were outdone by Gruitheisen, a most ardent and diligent observer of our satellite, who, with Schrœter's maps and conjectures before him, enlarged considerably upon both, and fancied he detected the works of intelligent beings—such as roads and canals, walls and fortifications, or enclosures. The manner in which he went to work was such as would be likely to lead to such discoveries. He collected with the utmost diligence all the objects which he beheld on the lunar surface having the appearance of regularity, such as would be shewn in the works of man here, and, strange to say, his search, with the aid of a somewhat wild imagination to help it, was by no means unsuccessful, at least as far as finding such objects, of which it seems there are several. One, says Mr. Breen, in his " Planetary Worlds " (a most excellent *vade mecum* for the moon-student), was near a crater called *Fontenelle,** *where he found a square wall formation,* and in the Mare Fæcundatis he found two craters, from which proceeded two bright stripes, than which nothing could be more regular. In the statement of them which he gives, they have the appearance of two *parallel roads,* terminating at a slight angle at the crater, and having a resemblance to the rays of light in a comet's tail.† Another consisted of three straight paths, connected at

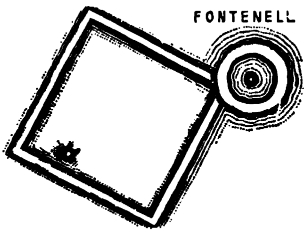

Fig. 1.

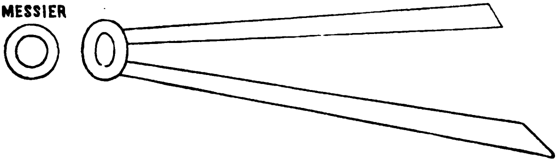

Fig. 2.

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* This strange square-shaped object, so different from the usual circular form of lunar walled plains, naturally enough suggested something artificial; as Beer and Mædler observe, " striking the observer with astonishment." That astonishment is, however, easily dissipated by a close scrutiny, when it is found that the walls are 64 miles long, and vary from 250 to 3200 feet in height, and upwards of a mile thick. This would indicate a race of giants, to which Brobdinags, or those slaughtered by the valiant Cornishman, were pigmies. There are, says Mr. Webb, parallel ridges in the interior, and in one place the form of a perfect cross.

† This remarkable formation was supposed by Gruitheisen to be an

acute angles, something in the shape of the inverted letter Z (fig. 3). Another, which he considered an artificial work of the lunar inhabitants, was like the letter H, being composed of two parallel lines, joined together in the middle by a third (fig. 4). Another was a curved line, crossed by four straight ones (fig. 5). Others consisted of four enclosed squares; while some were hook-shaped. These he considered

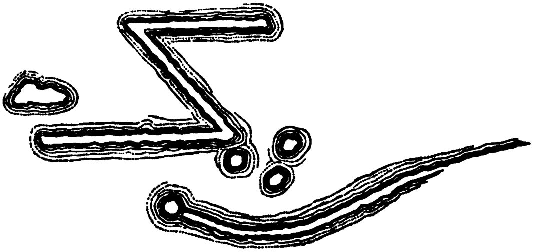

Fig. 3.

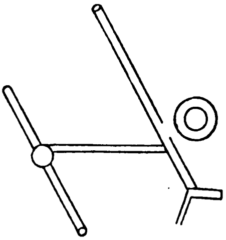

Fig. 4.

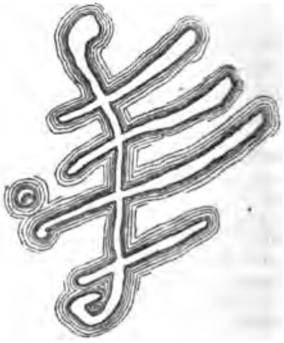

Fig. 5.

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artificial structure, and the cometary tail composed of *several* parallel lines. The great similarity of the craters from which these lines spring in size and appearance, together with the apparent regularity of the lines to be regular systems of walls, which had been erected for different purposes; but the key or explanation to all these strange marks, with their fancied regularity, was given in one, the most remarkable of them, which he detected near the crater called "Schrœter," 4° 45′ N. latitude, and 7° 30′ E. longitude, which consisted apparently of five oblong enclosures, which, according to him, underwent various changes.* Mædler afterwards examined this part very attentively with the great Berlin refractor, and found that these were valleys, the sides of which being of nearly equal height, as also their form and magnitude being very similar, gave them the appearance of artificial regularity,

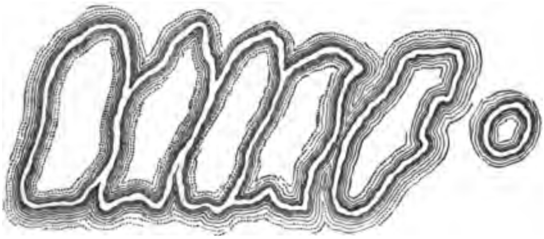

Fig. 6.

(springing from them at a slight angle), led in a great measure to this supposition. Beer and Mædler examined them more than 300 times without detecting the slightest change—from 1829 to 1837. The Rev. T. W. Webb, however, imagines he has perceived *decided evidence of modern volcanic eruption* in the two craters whose similarity, as recorded by Beer and Mædler, no longer exists. "In Nov. 14, 1855 (says Mr. Webb) I perceived with my 5½ feet achromatic that the E. crater appeared the larger of the two. In 1856, March 11, I found the W. crater not only the lesser, but lengthened obviously in an E. and W. direction. I have since noted the same dissimilarity with a smaller, as well as much larger instrument, though," he adds —(somewhat to the detriment of the observation) "I *have never yet had a really clear view.*"

* The Rev. T. W. Webb (Celestial Objects) says, "that the discovery of this formation, which at first attracted so much attention, fell into *unmerited oblivion*," and seems to think that some changes had taken place in its appearance during the interval of sixteen years that elapsed between

which increased when the shadow, falling from the east, wholly or partially filled them; and the changes (adds Mr. Breen) which Gruitheisen perceived between his own and Schrœter's map, are owing to the hasty drawings made by the latter, in which only the conspicuous parts were inserted—some parts, which Schrœter sketched in an hour or two, having engaged the attention of Mædler for several whole nights. Thus close and persevering systematic examination, with Pultor's instrument, resolved the imaginary marks into natural features, and dissipated the fanciful and ill-grounded conjectures of an enthusiastic mind. The observations of Mædler and his companion M. Beer were continued for seven years successively, and for 600 nights, during which period not the slightest appearance of change was noticed on the lunar surface.

This I can confirm myself. After sixteen years' frequent observation, I can say, with truth, that nothing can be more perfectly changeless than the form of that silent and, I am convinced, tenantless place. I remember, when first I commenced lunar observations, looking many a night with the most intense eagerness, in the hope of discovering (and thus immortalizing myself, as I thought, by so doing) some change, however slight. But no; no cloud, however faint, dimmed it; no shadow stole over it. On the same

its discovery by Gruitheisen, in 1822, and Beer and Mædler, in 1838, when only half the figure seen by Gruitheisen could be discerned by the latter. The imaginative character of Gruitheisen, however, together with the faintness of the object and the difficulty of seizing upon the right moment for its observation, likewise the extraordinary changes of *appearance* in all lunar objects, produced by the angle of incident light, renders the theory of any real change very questionable, while the general accuracy and fidelity of Beer and Mædler as sclenographists, proved indeed in this case by the lengthened period which elapsed before they could announce their discovery of it, puts the matter, in my mind, beyond all doubt as to any actual change having occurred in this district. Gruitheisen asserts that while he has shewn this object to several *German* philosophers, including Prince Metternich, no English astronomer has seen it; and thus taunts the English, "The scientific John Bull has gone empty away, and behaved himself about it just as his natural disposition led him."—Webb—"Celestial Objects." See also note in Appendix, page 137.

spots the same marks, shadows, and craters, reappeared in their silent calmness and majesty—in silvery beauty, or desolate wildness—but nothing moved, nothing changed; and were I there, I feel convinced I should find nothing breathed or stirred, nor *has* stirred for ages; that perfect silence reigns there, and motionless, breathless, windless nature broods over these arid wastes.

The idea of lunar roads put forward by Dr. Gruitheisen (which, were they so indeed, would imply a race of giants, as the least of them, when measured, is 5000 feet wide) is probably accounted for by certain marks or lines, to which the name of rills has been given by astronomers, and which may be numbered among the more modern telescopic discoveries in our satellite. These were long straight or curved lines, which are found in considerable numbers in various districts, some of them extending to 150 miles in length, the narrowest of them some 1000 feet in width. They frequently pass or cut through any crater that they meet with in their course. One in particular is mentioned by Mr. Breen as cutting through the crater called Hyginus, and which was first discovered by Schrœter. It is situate near the middle of the moon's disc, in the sinus medii. It is 106 miles in length, and 5000 feet in breadth, and appears, at the time of full moon, as a clear, white line; while, at the time of the first quarter, the shadow

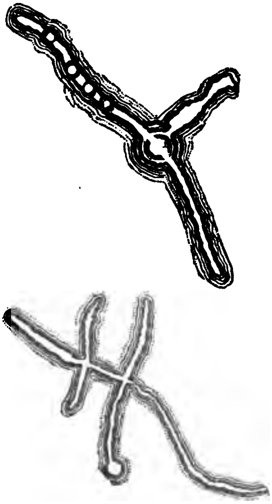

Fig. 7.

of its wall, as it dips below the surface, may be seen as a well-defined black path. It was noticed by Mædler as passing through ten craters, of which Hyginus was the fifth. On one very favourable occasion, the same indefatigable observer noticed where the rill cut through the wall of Hyginus, leaving a small but perfectly distinct and dark shadow or notch where it was breached; he therefore concludes that the rills were some of the latest eruptions in the moon, and have been produced by perfectly local causes, as in this instance, it is clear that the wall of the crater Hyginus has been broken through, and that the fissure passes through the interior with raised sides. It would seem, in short, that these rills are cracks or ravines on the crust of the moon, were originally produced by volcanic action, or the contraction of the lunar surface as it cooled down, with landslips in the weakest part of the crust. The interior, says Mr. Breen, looking at another of them (Ariadæus *) through the great Northumberland telescope, with a power of 500, is very irregular, and much broader in some parts than in others. The raised edges of the sides could be seen tipped with faint sunlight, and stretch-

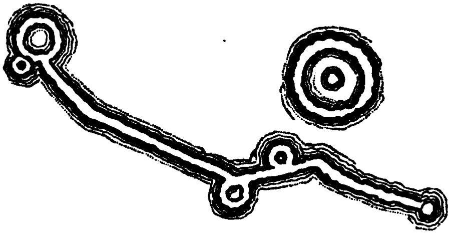

Fig. 8.

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* A little to the west of Hyginus, and much longer and broader, and probably deeper. The course of this canal has been traced by Lohrmann for 175 miles, a length considerably exceeding that of the river Shannon in Ireland. It passes two mountains in its course, and cleaves a third, as in the case of Hyginus.

ing a short distance into the dark part of the moon's disc. Their depth is unknown, but probably is very great. In *that* they seem to be in conformation not unlike many of our terrestrial glens and deep ravines, though on a much more extensive scale, but without a drop of water or vegetation as in ours.

The existence of active lunar volcanoes was advocated by Sir W. Herschel, who likewise thought it probable that there might be a cloudless atmosphere of great tenuity and little extent, and not impossible that water might exist, though in small quantity. He also indulged in the idea of partial vegetation, and the possible existence of inhabitants. Although the opinions of so eminent a man are deserving of the highest respect and consideration, the experience of modern astronomers, with better instruments, does not seem to confirm his conjectures in any of these particulars, and has, at the present time, very few advocates remaining. Among these, however, one has lately appeared, whose eminence, not only in every department of science, but as a Christian philosopher, entitles him to an equal measure of respect and attention—I mean Sir David Brewster, who, in his most delightful volume, "More Worlds than One," appears to go even somewhat beyond Sir William Herschel in his opinions upon this subject, and boldly defends the theory of an atmosphere, water, and inhabitants for the moon. As this work by Sir David purports to be a reply to an anonymous essay, entitled "On the Plurality of Worlds," and the object of which is to prove, not as its name imports, that there are many worlds inhabited, but that there are none (this excepted), it may naturally be expected, *a priori*, that Sir David would endeavour to people as many worlds as he can; and that he has succeeded in doing so, and with no slight effect and ability, in reference to the magnificent globes that roll, attended by their satellites, in silent majesty through the distant parts of the dominions of the Almighty, all will acknowledge who have read, as I have myself, with indescribable pleasure and profit, the very fascinating work referred to. But Sir David will pardon me for saying—in reference to the moon—I do not think he has been proportionately successful in proving his case; at all events I remain still a sceptic as to its habitability. And here perhaps I may be permitted to remark, that the habitability of the moon does not appear to me to be a question of any importance, as a support for the argument for a plurality of worlds; for which latter doctrine there are abundant evidences without her, and in no case (could the question even be positively determined) would her testimony in the matter, as it appears to me, be conclusive or satisfactory to either party in the controversy.

For instance, the essayist endeavours to derive an argument from the moon's deserted state to a like state of desert in every part of God's dominions but the earth; but, granting he had proved it, Sir David may very safely make his opponent a present of his desert moon, and of the argument deducible from it, for what it is worth, which is very little; for it by no means follows, if our moon were but a cinder, as the essayist contends she is, that every other moon or planet in the heavens is likewise a cinder; nor (to take Sir David's side of the question) does it follow that the conclusion deduced by him from the converse, were it certain, would be decisive; and were it discovered to-morrow that the moon was largely peopled, would it be necessary to believe that every other moon and planet in the heavens was in a similar condition. In truth, the moon's evidence is but a small item in the account, and but feeble testimony on so grand a subject, one way or the other; while there is danger, in such reasoning, of confounding analogy and identity, which are not one and the same thing. But I feel, with reference to the deeply-interesting and glorious question of the plurality of worlds, so ably and beautifully developed by Sir David Brewster, that it has a far wider and firmer basis to stand upon. It seems, indeed, as though that anonymous essay had appeared, in the providence of God, for the purpose of drawing out and establishing permanently in the minds of men the great truth it seeks to overthrow. But the advocates for a plurality of worlds can at all events afford, should facts seem to require it, to give up the question of the moon's habitability as a testimony to it; and, for my part, I can even imagine that its advocates can meet their opponents on better and safer grounds by conceding to them altogether the inhabitability of the moon. If I can shew, as I have endeavoured to do elsewhere, that the satellite worlds were made for a great and special purpose—viz., the enlightening and regulating the climatal arrangements of other worlds—then the circumstance of their own habitability is not only an unimportant item, but their desert state—*i. e.*, without intelligent inhabitants—would shew but the more strongly the main purpose or design of the Creator in placing them in their appointed positions with reference to their primaries; and the fact irresistibly follows of the inhabitation of those planetary bodies, of which they are the night-lamps; to give light to the eyes of whose inhabitants, every movement, however slight, seems to have been arranged prospectively, and to be the great object of their creation.

That they may, indeed, subserve a secondary end, and be themselves, some of them at least, the abodes of sentient or intelligent creatures, is neither impossible nor improbable; but the satellite worlds seem to be exceptions to the general planetary arrangements of the solar system; their peculiarly slow revolution on their axes, causing the strange climates and divisions of time that they do, make it exceedingly improbable (setting aside other considerations) that any material beings like ourselves can or do exist in any of them, but only the more reason (as I conceive) for concluding that such beings *do* exist in the worlds which they light. But these are arguments *a priori*, and are only advanced for the purpose of shewing that, as regards the question of the plurality of worlds, while our satellite may give her testimony *as such*—*i. e.*, as a satellite merely—along with the others that belong to and shine for other worlds, as she does for us, yet the question of her habitability is a different matter, and is as unnecessary for the argument as, I think, it will be found useless to attempt to prove it.

Having said thus much upon a subject deeply interesting, but which has had little left to be said upon it, after the two remarkable works referred to have been read, I may revert to the facts from which, as I apprehend, the desert state of the moon may be proved.

Sir David Brewster says, in the work already referred to—"I have been surprised at the facility with which Dr. Lardner, Mr. Nasmyth, and Mr. Crampton have given up the idea of an atmosphere in the moon, without assigning any valid reason for their opinions ; maintaining, as they do, that the moon's surface is covered with the craters of countless thousands of volcanoes, and knowing that, in the opinion of all philosophers, volcanoes are produced by the elastic force of gases and vapours which eject the melted lava, and themselves issue along with it into ethereal space, how can they suppose that these gases are again destroyed, and do not (as they must) form an atmosphere round the planet ? Every planet, whose surface has been perforated with volcanic vents, must necessarily have an atmosphere. Matter, without water and gaseous elements, either as adhering substances or essential parts of it, is unknown to science. The water of crystallization of lunar matter must have been set free during the agency of volcanic forces, and have taken its place round the body of the moon," etc. —*Vide* "More Worlds than One," pp. 107, 108.

As this is an argument I have not met with before, and as Sir David has done me the honour to refer to the opinions I have put forward upon this subject, I avail myself of the opportunity he has so kindly afforded me to reply, at least for myself, as doubtless the eminent astronomers with whom he has associated me in opinion will be enabled to do for themselves; but, in doing so, I must confess I am inclined to imitate the caution of the astronomer in Fontenelle's "Plurality of Worlds," who when the marchioness, with whom he conversed about the habitability of the moon, says, "I confess I have often heard talk of the world in the moon, but I always looked upon it as visionary and mere fancy," replies, by saying, "and it may be so still. I am in this case as people in a civil war, when the uncertainty of what may happen makes them hold intelligence with the opposite party, and correspond with their very enemies, for though I do verily believe the moon *is* inhabited, I live civilly with those who do not believe it; I am like some honest gentlemen, in point of religion, still ready to embrace the prevailing opinion; but till the unbelievers have a more considerable advantage, I declare for the inhabitants of the moon."—Fontenelle's "Plurality of Worlds."

These sentiments I fully participate in, with the slight difference of taking the side of the unbelievers on this occasion; and, until the believers have something more to shew for their inhabitants to exist upon than the moon appears to me to have for them, as far as can be discovered, I declare for the unbelievers, feeling at the same time the utmost respect for the opinions of those who differ from me. With this preface, then, I venture to reply to Sir David Brewster's views and arguments for a lunar atmosphere and inhabitants. And in the first place I may here remark, that I have by no means given up the idea of the possibility of some kind of atmosphere to the moon, contending only that if it *be* there, it can bear no analogy or resemblance whatever to that which envelopes our planet; and that whatever be its constituents or ingredients, it must be of so great tenuity as to be equivalent to what is called here a vacuum. That some gas or gases may exist in a solid, fluid, or even aeriform state round the moon is, I think, quite possible, or even probable;

but granting that, to what does it amount ? or what possible semblance or analogy could such a gaseous envelope bear to that of the earth and the other primary planets, whose atmospheres are plainly perceptible to the telescope? It is wonderful, indeed, how small an amount of air the advocates for the moon's atmosphere are content with. Give them but as much as will remain under an exhausted receiver, and it is sufficient for their purpose. Straightway our satellite is clothed with verdure and thickly populated; yet any one who has ever witnessed the experiment of placing either a living animal or a vegetable under such an instrument, may form a tolerably fair notion of the nature of lunar verdure, and of the trees, fruits, and flowers which would grow there, and the length of time during which a terrestrial creature would exist upon its surface. It is to no purpose to argue from the *possibility* of such substances and creatures existing, notwithstanding the tenuity of the atmosphere ; it is possible they might. The power of the Creator is not limited, and he might cause life and verdure to exist without any atmosphere as easily as he might create animals without lungs. That is not denied. But the *possibility* of a thing is but a feeble argument for its *reality*, while the improbability is strong against such a conclusion. But, say the advocates for a miniature earth in the moon, may there not be climatal arrangements in the moon different from ours, by which water and verdure are preserved in spite of evaporation ? and may there not be inhabitants with no lungs, or at least lungs *suited* to the thin atmosphere that prevails there ? may they not be creatures that require no sleep for a fortnight, and then sleep for the next fortnight? may they not be angelic, spiritual beings, that require no habitations, and are unaffected by rare atmospheres, and intense heat or cold ? To such speculations and inquiries the only reply that can be given is—1st, that there is no proof whatever of such things ; and, 2dly, no limit to such imaginations ; in truth it would be just as fair to include among such questions an inquiry upon the old nursery story, "Why should not the men in the moon carry their heads under their arms?" There is no better reason can be given why they should not, than can be given why they should be all that has ever been said or imagined upon the subject, for to that imagination there can be no limit, once we depart from the great Newtonian principle, that the laws of Nature are uniform in all her dominions. Taking this for granted, such conditions as are here supposed would not be possible except by miracle. If, for instance, it be maintained that water exists in the moon, because of its analogy to the earth, then it follows necessarily that the laws that are in operation upon the earth with regard to that fluid will hold good in the moon. If this is not admitted, it is evident water is not water in the moon, but something else, as things are known here by their properties; and we wander in a terra incognita, all analogy, and the arguments derived from it, must cease. If it *is* admitted, then the inevitable consequence is, that there can be no water there, except indeed a perpetual miracle be performed, which is not very probable. Thus those who resort to the analogy of the earth as an argument for the inhabitability and fertility of the moon, when peopled according to their imagination, do not see that they are obliged, in the very first step which they take, to destroy the force of their own argument, and ruin their own cause. And so in like manner with regard to inhabitants, either the analogy must cease to be resorted to altogether, and then we know nothing about them, or if it is retained, such inhabitants must be subjected to the laws we are acquainted with in reference to ourselves.

But Sir David Brewster states that every planet and satellite in the solar system must have an atmosphere. In the case of the moon he says—"The gases emitted during her active volcanic period must still remain, either in a solid, or crystalline, or æriform state."* If the latter, indeed, could be proved, Sir David might make out an atmosphere; but whatever gases may exist there in a solid or crystalline form, there is no *proof whatever* of their existence in an aeriform state. On the contrary, the evidence is all against it; while the fact of their existence in a solid state, provided it could be proved, would not give a lunar atmosphere in the sense in which it is required by analogy with the earth—viz., as a breathing apparatus for the vegetable and animal creation, and the other needful and important purposes which the atmosphere which engirdles us subserves. The probability is indeed very strong, that the hypothesis which Sir David puts forward is the fact, so far as the existence of an atmosphere in a solid or crystalline form upon the surface of the moon is concerned, but if there be any, it is either congealed by intense cold, or reduced to a solid state by influences with which we are not acquainted.

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* "More Worlds than One," p. 107.

Many of the gases of which our atmosphere is composed exist in a solid or crystalline state, and are capable of being converted from an aeriform or invisible and vaporous state to a solid, and *vice versa*, by the action of intense heat as well as cold, both influences apparently in powerful operation upon the moon's surface once in her former history, if not now: gases also may be absorbed by some substances when in either a fluid or aeriform state; and it is not difficult to conceive a state of things in which, by chemical action, absorption, and the application of intense heat or cold, the gases or atmosphere which issued from the volcanic vents originally were not annihilated, but converted into fluids and solid crystals so completely as not to leave a vestige of an aerial envelope around the body of our satellite. This would be specially applicable to the case of those gases which issue from *volcanic* vents, such as are scattered in such numbers over the lunar surface, if they bear (as I think there is no reason to doubt) any analogy with those that perforate the bosom of our own globe. Many of the gases peculiar to active volcanoes have been converted into solids, some into liquids, by Dr. Faraday, by the application of intense cold. Sulphurous acid gas, hydrogen, chlorine, ammoniacal gas, hydrosulphuric acid gas, carbonic acid, hydrochloric acid, and nitrous oxide, have all been thus liquefied. Hydriodic acid and hydrobramic acid could be obtained either in a *solid* or a liquid state. Sulphurous acid, *froze* into transparent and colourless crystals; sulphuretted hydrogen, one of the gases most largely emitted from volcanoes, *solidified* in masses of compound crystals of a white colour, at a temperature of 122° Fahrenheit. Euchlorine was easily converted from a gaseous state into a *solid crystalline body.* Nitrous oxide was obtained solid at the temperature of the carbonic bath in vacuo. Ammoniac was obtained in the state of solid white crystals, and retained this form at a temperature of 103°; and although oxygen, hydrogen, and nitrogen, and carbonic oxide have not yet been either solidified or liquefied, who can say, supposing them to exist in the moon, that that is impossible. Great compression—heat or cold more intense than can be applied here—solution in water frozen into perpetual ice—their absorption by charcoal and other porous bodies, may hold all the gases which, in an aeriform state, might otherwise have formed a gaseous envelope round our satellite, fixed in a solid state as adhering substances.

Dr. Lardner, as well as Professor Ponzi, an eminent Italian geologist, believe that a state of perpetual and intense cold is the probable climate of the moon, and that, consequently, all gases or fluids that may have once existed there remain fixed, being converted into crystals, or thick-ribbed ice. Telescope observation, indeed, would seem to confirm such a supposition as being, at all events, highly probable, and would account for many strange appearances which I have myself seen, more particularly the extraordinary diamond-like brilliancy reflected from some spots, most of them indeed situated where we might expect to find ice, at the summits of the loftiest mountains, but not confined to them.

Dr. Lardner says, with reference to this subject, "It appears to have escaped the attention of those who assume the possibility of water in the *liquid* state in the moon, that in the absence of an atmosphere the temperature must be not only far below the point of congelation of water, but of most known liquids; even within the tropics and under the line with a vertical sun, the height of the snow-line does not exceed 16,000 feet, and, nevertheless, at that elevation, and still higher, there prevails an atmosphere capable of supporting a considerable column of mercury. At some greater elevation, but still in an atmosphere of very sensible density, mercury is congealed. Analogy, therefore, justifies the inference that the total, or nearly total absence of air upon the moon, is altogether incompatible with the existence of water, or probably any other body in a liquid state, and necessarily implies a temperature altogether incompatible with the existence of organized beings in *any respect* analogous to those which inhabit the earth."

Professor Ponzi is of opinion (says Mr. Breen) that water once existed on the surface of the moon, but that it was now cooled to the temperature of the planetary spheres (about 100° below zero), and is changed to regions of thick-ribbed ice, which, notwithstanding the intense glare of the sun, remains unmelted from the tenuity of the atmosphere, and is thus like the perpetual snow and glaciers on some of the mountain-summits of our own globe. Cold, and other unknown causes, he thinks may have tended thus to fix the atmosphere in the same manner, as the vast atmosphere of the earth has been changed and reduced to its actual composition by various chemical processes. But be this as it may, the theory advanced by Sir David Brewster, that whenever there has been volcanic action in a planet, there must necessarily be a perpetual atmosphere formed of the gases that issued originally with the ejected lava, does not appear to me to be conclusive, as, unless it could be proved that such gases remained there now in their *aeriform state*, the planet from which they issued would be virtually without an atmosphere.

With reference, then, to the nature of the atmosphere which it is within the sphere of possibility to exist in the moon—1st, its great tenuity and cloudless nature must be admitted by Sir David himself, from many proofs that may be given of it. As to the existence of water, although clouds seen on the surface would be a sufficiently decisive proof of an atmosphere analogous to ours, and, consequently, of the waters that produce them, yet the absence of cloud *alone* would not be a sufficient proof of the absence of an atmosphere of *some kind* which did not take water into its composition as an ingredient. Yet, without water, what vegetation could exist? True, some advocates for a lunar atmosphere and vegetation have said, that as there are districts upon the earth where rain never falls, and, consequently, a cloud is never seen, why may not the moon have such a clear and cloudless atmosphere as these districts, and yet have water in its composition as an ingredient, proceeding from large deposits, either seas or lakes, if not on the hemisphere next to us, at least on the other side, and the moisture which is necessary falling only in copious dew on the side next the earth? All that can be said in reply to this is, that it is just within the sphere of possibility, but in the highest degree improbable, that such an arrangement should subsist there. In the terrestrial districts alluded to, the air, although far removed from the ocean, or large deposits of water, and cloudless, is largely saturated with moisture derived from those very deposits, and carried thither by the winds. Nothing indeed could prove this more fully than the copious fall of dew which always takes place in such districts (always plentiful, indeed, in proportion to the absence of clouds and rain), for the fact is, that the supply of dew is always dependent upon the degree of saturation of the air, which, when it reaches its highest point, and not till then, and the temperature is too warm to condense it into rain, is converted into water or dewdrops when brought into contact with objects colder than itself, such as plants, trees, blades of grass, and flowers. Thus nature compensates for the absence of rain, and the absence of clouds hastens and increases the process by radiation of heat, thus reducing rapidly the temperature of the vegetable world, and causing copious showers of dew to be distilled from the air around them, plunging them, as it were, in an aerial and vapour bath.

Now, in order that this process may be carried on in the moon, it is evident that there must be large deposits of water somewhere, such as will thoroughly saturate the air on the hemisphere of the moon next to the earth, where no cloud is ever seen, and where, consequently, dew must take the place of rain. But is it likely such deposits do exist upon the other hemisphere of our satellite, without their presence being discovered by the keen-sighted observers of the present day? If they did exist, would not clouds be formed *there* over those deposits, exposed, as they must be, to the intense heat of the solar rays for a fortnight? And if they did, is it probable that we should never catch a glimpse of a cloud floating on the limb of our satellite? The existence of large seas and clouds without wind would be most improbable, while if wind existed, it would be a perpetual miracle that would keep the clouds all fixed to one hemisphere, not one ever stealing, even for a moment, round the edges, and shewing itself in our hemisphere. If moisture and saturation are to be kept up on the surface of our satellite, and dew to fall, it will be absolutely necessary that a continued current of air should set in towards the cloudless hemisphere, carrying with it the watery vapour taken up from the aforesaid ocean; but all this must be allowed to be in the highest degree improbable. No change on the surface indicates the faintest breeze playing there, nor has the shadow of a shade of a cloud ever been observed on the edge of the two hemispheres, while the appearance of that which is next to us gives the careful observer an idea of barrenness and desolation only to be found under lunar conditions, and which, in my opinion, would not keep alive for five minutes the dryest lichen that springs from the rock, much less the vast amount of vegetable and animal creatures that, under circumstances in any way analogous to the condition of the earth, would be found there. An entire new animal and vegetable world, in fact, must be specially made for them, in which all trace of analogy with this globe must be lost and dismissed.

But the astronomical as well as optical proofs of the non-existence, or, at least, great tenuity of the moon's atmosphere, are such as it appears to me dissipate for ever the slightest doubt that could be entertained upon the subject.

Any person possessed of the merest elementary knowledge of optics knows the effect which a transparent medium, such as our atmosphere produces upon light when transmitted through it, viz., that the rays are bent out of the straight or rectilineal course which they would otherwise have, and reach the eye at a different point from that at which they would be seen were there no such medium. This effect is called refraction, and the angle which the refracted ray makes with the straight ray, is the measurement of the amount of refraction, which will be greater in proportion to the density of the medium through which it passes. The effect of refraction is strongly illustrated by the familiar experiment of dipping a piece of straight stick into water, when the portion under water will be perceived to be bent at an angle from its straight course, and makes the stick appear crooked. This effect every star and planet in the heavens is subject to before it reaches us, their light having to pass through the transparent medium of our atmosphere. The consequence is, that we do not see any star or planet in its real place in the heavens, but in that which the law of refraction puts it.

It is necessary, therefore, in all observations, to make allowance for refraction, and accordingly astronomical tables are constructed for the purpose, shewing the amount of refraction due in each case, and by which we are enabled to tell with precision the real place of the star or planet. Now, what is true of our atmosphere must be equally true of the lunar atmosphere, if there be any, and were it ever so thin, yet if sensible at all, it could be detected at once with the utmost precision and certainty. Thus, as the moon performs her circuit in the heavens, occupying, as she does herself, half a degree in diameter, all the stars found in this zone must be occulted or concealed by her as she moves on. Now, every star thus to be occulted is most certainly known beforehand, and a list of them is accordingly given in all astronomical almanacs; their place in the heavens is likewise known, as well as that of the moon at the time of occultation, so that the exact part of the moon's disc, across which they will apparently pass from her centre to her edge, can be determined to a hair's breadth; and as the fixed stars have no perceptible motion of their own, while the rate of the moon's motion is known exactly, the time, therefore, which it will take for any star to pass across any given point of her disc, or the exact interval that ought to elapse between the disappearance of a star on one side of the moon and its reappearance on the other, can be computed (on the supposition of no atmosphere) with the most perfect mathematical precision. Now, on the supposition of a lunar atmosphere, such a computation would be found to differ from the actual observation of the star's passage by just the amount of refraction which such an atmosphere would occasion, and the effect would be (supposing the moon *had* an atmosphere), that the ray of light from the star, as it passed behind the limb or edge of the moon, being bent outward, would cause it to be visible after it had really passed behind it. And, on the other hand, being bent out again from the opposite side, would make it visible before it had really emerged; in other words, it would disappear *later* and reappear *sooner* than it ought—in fact, would be a shorter time hid than it should. Now, this is not found to be the case, the computed time and the actual time agreeing in almost every instance perfectly, and proving thereby that there is no disturbing cause, such as an atmosphere, to produce such an effect. Some advocates for a lunar atmosphere, and others, have indeed said that they have observed occasionally a difference of a second or two between the computed and actual time of the star's passage, and there is just enough of practical difficulty and delicacy in the observation itself, to allow for a doubt one way or another; but granting even that such were the case, at such an amount, what would be its tenuity? The best air-pump can only rarify air till it supports a column of mercury 1-25th of an inch, and then allowing for the difference of 2″, it would be balanced by a column of mercury 1-45th of an inch, which would still leave the atmosphere at a tenuity to which the term vacuum may fairly be applied; and then, inasmuch as the atmosphere of the earth supports a column of 30 inches of mercury, while one a thousand times less dense would support about the 30th of an inch, in fact, just such an atmosphere as is indicated by the difference of 2″ between the computed and actual passage of a star, it would amount to just such a vacuum as a good, though perhaps not the most perfect, air-pump could produce. It is nothing either to say, as some do in reply, that owing to the great number of lofty mountains in the moon, the stars always disappear at their summits, where (as in the case of terrestrial mountains) the air is necessarily more rarified than at their feet; for, as it is certain that *all* stars do not disappear behind mountains in the first place, so the law by which any atmosphere becomes more dense may be ascertained at any height. And taking the density already supposed at the summit of a lunar mountain 25,000 feet high, and measuring downwards, it will be found (says Mr. Breen) that the atmosphere will only be three times as dense at its foot as at its summit, which leaves it still what may be termed a vacuum.

The twilight said to be seen by Schrœter, and one or two others, has been contested, and contested by Mædler, by far the most careful and accurate observer of the two, and whose map is in itself a proof of the close and continued scrutiny to which he has subjected our satellite, while it has not been confirmed by the vast number of astronomers, both professional and amateurs, who are continually engaged in examining her surface. That surface, indeed, presents no appearance such as a planet having an atmosphere would; for the terminator, or boundary line of light and darkness, when she is half enlightened, presents the same distinct and sudden break that might be expected from the sudden disappearance of the stars at the edge, and which, when occulted by her disc, are extinguished in an instant; whereas in Venus, under similar phases as the moon, the line of the terminator is softened or shaded away, so as to make it difficult to say where it begins or ends; and her twilight caused by her atmosphere (as ours), is distinctly visible, as doubtless ours is to her inhabitants, and as must be the case in all planets provided with an aerial envelope. Many of them, indeed, give evident tokens of such an appendage, by causing the partial obscuration of other stars which approach them closely; and Jupiter has been known, in one particular instance, to be nearly obscured when within 6′ of the planet Mars. Hence from all that has been considered, I am led to think, with great respect to all that differ from me in opinion, that there is not as much atmosphere in the moon as would keep alive an animal or vegetable belonging to this world for half a minute of time; and however anxious I might be to maintain the more interesting doctrine of an atmosphere for our satellite, I have been constrained, by what appears to me the most forcible testimony, to give it up, and with it all idea of vegetation or life.

With reference to volcanoes in the moon, and volcanic action in general, I must refer my readers to the "Lunar World," where my opinions are stated,* as well as those of Mr. Nasmyth, than whom, perhaps, there cannot be a more competent judge in the kingdom; but I may add here, that closer observation of the lunar surface induces me to believe, with Professor Philips, what indeed I had often thought before, that there was a day in the lunar history when water was spread upon her now silent and desolate plains, and that many of the volcanoes at present visible were submarine. The traces of watery action can, I think, be discovered in those plains, and upon the volcanoes or craters. And here I may mention a curious confirmation of the volcanic nature of the circular pits and plains visible in our satellite, if indeed a doubt exist of their true character. Having obtained drawings of two lunar craters by Mr. Nasmyth, which were published in the Royal Astronomical Society's transactions, I hung them, together with others by myself, as depicted in "The Lunar World," in my drawing-room. A gentleman who had lately returned from Ascension Island,† and a stranger to me, on entering the room for the first time, exclaimed upon seeing them, that they were so like the scenery of that remarkable volcanic island in which he had resided some years, that nothing could more perfectly represent it. He said that the circular form and áppearance of the craters was *identical*, and that in one plain in Ascension Island several of these circular craters were scattered about, of various sizes, from a few feet in diameter to one of about three acres in area, called from its appearance the Devil's Riding School. It had a slight rise or elevation in the centre, and a rim or rampart of considerable height around it, but no volcanic aperture in the central elevation; the plain, which consisted of decomposed lava or scoria, was below the surface or crust of the island. This island is a decided volcanic product, and may be classed among those which are called submarine, the character of its desolate scenery being such as plainly to tell its former history, though what its probable age is, or the exact period at which it first appeared, cannot be determined (probably during the tertiary period). It is, at all events, the top of a volcanic mountain, which at some former period was below the sea, and was raised from the bosom of the deep by an eruptive force from below; and, consequently, the surface, indeed the entire island, presents just such phenomena as may be expected to be found under such circumstances, but with this peculiarity, that being an island far removed from the mainland, or any source of vegetation supplied to other similar formations differently situated, it presents still the naked and utterly barren surface which probably, when first it rose from the depths, the entire surface of the globe we inhabit once did at the commencement, or during the era of the tertiary periods, ere Nature had disguised it and clothed it with a garment of green, and thus presents a curious analogy, I might almost say *identity*, with the present condition of the moon as revealed by the telescope. If this be so, indeed, the conclusion which it presents is deeply interesting, as throwing light on the present geological condition of the moon. It tells us that were we enabled to see the earth as it was, either *before* or *during* the eras of the various sedimentary deposits, and the tertiary formations, before the alluvium and diluvium, and the glorious vegetation that now spreads its mantle of many colours over the landscape, we should readily perceive the close analogy that subsists between terrestrial and lunar geology; but now the wild and rank luxuriance of nature upon the surface of our globe (from which Ascension Island by its position has been excepted) enamelling the plains and purpling the mountains, softening their rugged outlines, filling up the terrestrial basins, and clothing their sides with mingled rock and wood, or breaking their uniformity with lake or river, and instead of the dreadful monotony of lunar or Ascension Island scenery, presenting all the beautiful irregularity of picturesque landscape with which we are familiar—all this, while it explains the difficulty of any but a practised observer of both countries recognizing the similarity in both cases, seems to my mind to establish, in an extraordinary manner, the identity of the agency at work in both worlds, which differ from one another only in the geological era or stage to which each has respectively advanced in their history. The fact is, at all events, established, that as far as human vision can testify to it, there is a spot on this earth which resembles, as closely as possible, the entire configuration of the lunar country, and as such may prove an important key for investigating the geological condition of our satellite.

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* See also "Excelsior," Vol. IV. Art. I., "Night Views from My Window." London: Nisbet and Co.

† Ascension Island lies in the South Atlantic Ocean, 520 miles from the nearest point of land, which is Mathew Island. Its geographical situation is between Africa and Brazil. St. Helena is 685 miles to the S.E. of it, while it is distant from the Coast of Africa no less than 1450 miles. It is a mere speck in the vast ocean which surrounds it, being but seven and a half miles long, by six miles wide. Its surface is composed of lava mountains of a conical shape, black or brown, the highest attaining 2800 feet. To the top of this, called the Green Mountain, artificial soil has been brought and cultivated, the only green thing there. Plains of decomposed lava, scoriæ, and pumice, presenting an unvarying black, brown, or grey, fill up the picture of its desolate and dismal scenery, the first glimpse of which, as the voyager catches from the deck of the ship approaching it, and sees its dark and precipitous lava cliffs, against which the ocean swell for ever thunders, or steps on shore and looks upward at the black and pointed mountains around him, leaves an impression never to be forgotten; the dreariness of which is perhaps unequalled by any other spot on our globe, and would only be realized elsewhere, were we transported to the surface of our smiling and beautiful satellite—lovely just in proportion to our distance from her.

I may here notice a recent theory, and conclusion derived from it, advanced lately in some books containing articles on popular science, and in the "scientific gossip" of some of the leading periodicals. It is the theory of Professor Hausen, a continental astronomer of some eminence, who conceives that he has ascertained the important fact that the moon's centre and centre of gravity are not coincident, there being a distance of eight geographical miles between them. The result of this is that the density of our satellite is unequally divided—the heavy portion being at the side turned away from us, and the lighter that which continually faces the earth.

This, as a mathematical deduction, is a matter of much interest, and the method of its discovery not less so. It may perhaps be popularly explained thus:—Spherical bodies shot from a gun, such as musket or cannon balls, describe different curves proportioned to their density, a ball of equal density on every side describing a different curve from one of unequal density, of which one side is heavier than the other. Given the density, the curve can be ascertained; or (taking the converse) given the curves, the density can be ascertained. Now apply this to the moon, which is but a cannon-ball shot forth from the Divine hand at 2000 miles an hour; we know the curve she describes, and we can from this ascertain her density. This Professor Hausen asserts he has done, and the result is as has been stated. Her density is unequal, her centre of gravity being separated by a wide interval from her real centre.

However interesting or important the fact thus deduced by Professor Hausen, the conclusion appended to it by others does not appear to me to be equally cogent.

This great discovery is made use of to tell upon the question of the moon's habitability thus—that the side next the earth is thus virtually made the top of a vast mountain, twenty-nine miles high, from which, of course following the irresistible law of gravity, both water and atmosphere (if any there were), descended to the lower and heavier regions of our satellite on the opposite face, where they now are, and which accordingly is the habitable part, while the portion next the earth is the summit of a desert and volcanic mountain, more inaccessible and inhospitable to Lunarians than our own Alpine heights are to us, because not only separated by a much greater distance, but being utterly barren and desolate (as we perceive with our telescopes), and, above all, destitute of atmosphere or water;

no inhabitant of the silvery sphere would venture to look round the corner (if corner there could be) of such a district, much less to climb its dreary and airless heights.

It is not wonderful, therefore, that we see no inhabitants on our side ; for the same reason, we never see a cloud encroach upon this region, being retained by the power of gravity for the use of the busy population who are all on the other side.

The ingenuity of this conclusion, from the philosopher's premises, is certainly as amusing as it is creditable to the power of invention that first originated it. As to giving a reply to it, it would be impossible. It reminds me of an excellent but somewhat eccentric friend who gravely told me he had just read the "Lunar World," and had come to the conclusion the moon was "the Heavenly Jerusalem" that is to come down out of heaven upon the earth at the last days. On my modestly hinting that the appearance of the moon at present did not seem to resemble the city described in the Apocalypse, he exclaimed loudly and energetically (as was his wont when in earnest), "No, my dear friend ; that is the very point—that is the very reason why I have come to the conclusion. This side, it is true, *is* barren, but 'the Heavenly Jerusalem' is on *the other side*, purposely concealed from us till the time comes." This being said with an enthusiasm and conviction of its certainty that could not be opposed, I had nothing for it but silence and submission. I believe a similar mode of treatment may safely be adopted with the conclusion derived from Professor Hausen's theory.

APPENDIX.

NOTE A, Page 3.

SEVERAL of these photographs have been taken. "All the alternations of light and shade affect an iodized plate (says Humboldt), and I myself possess such a light-picture of the moon, of two inches diameter, in which the so-called seas and annular mountains are clearly recognised; it was prepared by a distinguished artist, Mr. Whipple, of Boston." —(Humboldt's "Cosmos," vol. iii. part ii. p. 362.) Since then the rapid progress of photography has enabled M. de le Rue, whose reputation as a skilful and able practical astronomer, is deservedly celebrated, to produce two stereoscopic pictures of the moon (two inches in diameter), than which nothing can be more perfect. The various spots and craters are delineated with a clearness and precision that enables an observer not only to see the general spherical configuration of our satellite, but to investigate every separate lunar feature, illuminated directly by sunlight or candle-light; while each picture having been ingeniously taken during the period of opposite librations, the entire, when under the stereoscope, exhibits a greater portion of the lunar surface *at once*, or *at one view*, than could ever be seen either by the telescope or the naked eye.

NOTE B, Page 6.

The *power* of a telescope here alluded to, by which the capabilities of these instruments are generally, though not truly expressed, relates to its *magnifying power* only. It is usual to express it thus, because when it bears a high magnifying power it must be a good telescope: yet there are other powers, or rather qualities, without which the magnifying power would be useless; such as its *penetrating power*, by which the image formed is repeatedly painted with light, and from being faint is rendered strong. This depends upon the size of the object-glass being in proportion to its surface or area, every point of which receives and transmits an entire picture. Then there is its *acromatic power*, or freedom from colour, produced by the different refrangibility of the rays of light, and—perhaps the most important of all—the power by which it is freed from spherical aberration, the effect of which is mistiness and want of clearness. The *magnifying power* is as the focal length of the object-glass divided by that of the eye-glass, so that the same eye-glass will produce different powers, according to the focal length of the object-glass with which it is combined; and, *vice versa*, different eye-glasses will produce different powers. The highest power applied with advantage (*i. e.*, preserving the other powers) to the moon is about 500, although I have seen her with a power of a thousand in Lord Rosse's twenty-feet reflector, but not so satisfactorily as with a much lower one. To the fixed stars much higher power may be applied with impunity.

NOTE C, Page 15.

The old method of computing the heights of lunar mountains, was to measure with a micrometer the distance from the top of the mountain, the moment it first becomes illuminated, to the terminator, or circle of light and darkness, in a direction perpendicular to the line joining the extremities of the horns. The practical difficulties attending this mode of measurement, however, have rendered it obsolete. It could, in fact, only be done at all when the moon was elongated 90° from the sun, and the measurements made by it are not now considered correct, having exaggerated the heights of the lunar mountains far beyond what more recent and accurate measurements allow. These are now made by careful measurement of the *shadows* with the micrometer.

It is a curious and interesting circumstance, that the possibility of this latter mode of measurement was suggested in very early times, when no telescope existed. Plutarch, in his small but very remarkable treatise on the face of the moon, says expressly, "that in the spots which we see we may *surmise* the existence partly of deep clefts and valleys, and partly of mountain summits, *which cast long shadows like Mount Athos, whose shadow reaches to Lemnos.*"

Humboldt, in that most wonderful and interesting work of his, "The Cosmos," adds an extract, in confirmation of Plutarch's observation, from a celebrated traveller, Pierce Belen, who, in a work of his, published in 1554, upon the "Remarkable Objects found in Greece," says: "The shadow of Mount Athos reached to the broken figure of a cow in the market-place of the town of Myrine, in the island of Lemnos."

Mount Athos, on the coast of Macedonia, stands in lonely majesty at the extremity of the peninsula or promontory that bears its name, and rises abruptly from the sea to the height of 6349 feet. The distance to which its shadow must be projected across the Mediterranean, according to the above statement, cannot be less than thirty miles, at which distance from the shore Lemnos is situated. In connection with this subject, may be mentioned an opinion or theory suggested to me lately by a friend, respecting the lunar spots, which he fancied he had been the first to imagine, but which (as there is nothing new under the sun) turns out to be as old as the days of Plutarch, and to have been actually contested against by that celebrated and sagacious historian—viz., that the spots and shades on the moon are only the reflection (as in a mirror) of our continents and oceans. So convinced was this gentleman of the truth of his theory, that he got a friend in the West Indies to sketch a map of the lunar spots as they appeared there, conceiving rightly upon his theory, that if it were true, she would present a different face. I have this rough sketch in my possession at present, but notwithstanding all the efforts of my friend to convince me of the difference, I am sorry to say I am still too dull to perceive it. Humboldt thus alludes to it: " Another '*very fanciful opinion*' respecting the spots on the moon was that of Agesianax (contested by Plutarch), according to which the moon's disc was supposed to reflect back to us catoptrically (as in a mirror) the forms and outlines of our continents and of the outer (Atlantic) sea." "An opinion quite similar to this (says Humboldt) seems to have continued as a popular belief in Western Asia to the present day." Finding it vain to contest the matter any further with my friend, I was rejoiced to have it in my power to hand him over to Plutarch and Humboldt. As a consolation to him, however, I may here add an anecdote of Humboldt, which shews, at all events, that his theory, if not correct, is at least *natural*—" I was once very much astonished (he says) to hear a very accomplished Persian of Ispahan, who had certainly never read a Greek book, to whom I was shewing, in Paris, the spots on the moon's face through a large telescope, propound the same hypothesis of reflection as that of Agesianax as prevalent in his own country. 'It is *ourselves* we see in the moon (said the Persian)—that is the map of our earth.' One of the interlocutors in Plutarch's conversation on the moon would not have expressed himself otherwise" (Humboldt's " Cosmos," vol. iii. part ii. p. 2, chap. cxxx.); nor would my, I believe, as yet unconvinced friend.

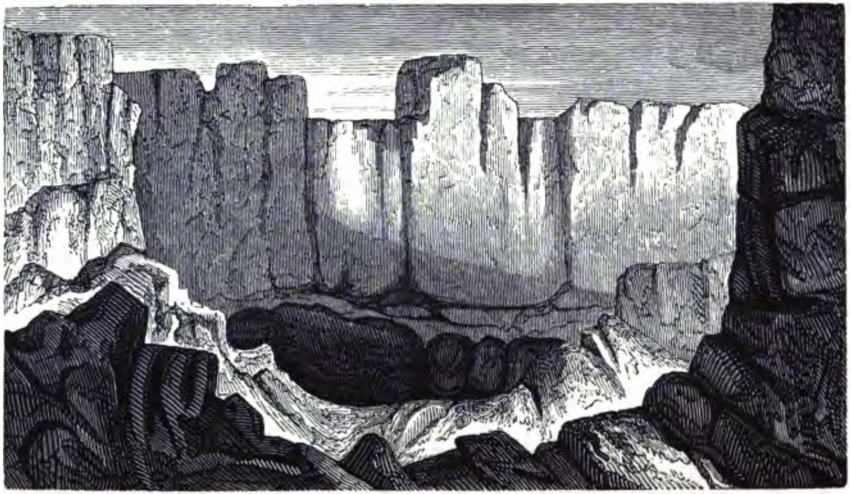

Plate VII.] INTERIOR OF TRUKKEE, AN EXTINCT CRATER IN THE CUTCHEE HILLS (INDIA).

Note D, Page 21.

Hooke says, speaking of this experiment with boiling alabaster:—" Presently ceasing to boil, the whole surface will appear all over covered with small pits, exactly shaped like those of the moon." "The earthy part of the moon has been undermined or heaved up by eruptions of vapour, and thrown into the same kind of figured holes as the powder of alabaster" (Robert Hooke's "Micographia," 1667; Note, Humboldt's "Cosmos," vol. iii. part ii. p. 131). It is now debated among geologists whether there are any volcanoes (properly speaking) in the moon, and whether her present state is not the effect of her cooling down from a state of fluidity (like Hooke's alabaster), especially as it is *said* by some that there are no lunar mountains with a crater or hollow at the summit. Unfortunately, however, for this theory, two are known to have them—viz., Arzachel (a mountain in the very centre of the moon), which has a crater on its very summit; and Hercules, which has a lateral crater. We should think a journey there alone could solve the question.

Note E, Page 22.

The following description, by Sir C. Napier, of Trukkee, in India, referred to in the plate, affords an instance of a *terrestrial* crater (now extinct) which bears a strong resemblance in its formation to those of the moon—as, indeed, it would seem the whole of that wild and dreadful volcanic district traversed by that officer and his brave companions does, to the lunar regions in the moon's southern portions, and in the neighbourhood of Tycho:—

"The general, after examining with great labour and fatigue all the approaches, scaled a high rock, from whence he looked into the interior of Trukkee, and formed a plan of attack—to be executed, however, only in the last extremity, for the place was, indeed, worthy of its reputation.

Resembling an extinct crater, it was twelve miles long by five or six broad ; and nature had most curiously contrived it—alike for secrecy and strength. For strength, because externally it presented a belt of rocks many hundred feet high, and nearly impracticable of ascent on the south side ; and though it was less austere on the north, the inside there was precipitous, while on the southern side it was comparatively easy of descent. Thus the whole circuit was equally impervious to assault ; and the interior was a vast collection of rocky hillocks, with chasms of different depths, yet all precipitous.

"For secrecy, because on the south was a second wall, or screen, of perpendicular rocks, some hundred feet high, forming, with the actual belt of Trukkee, a restricted valley, or rather lane, which was to be entered by narrow fissures before the passes into the crater could be approached ; and all the country for miles around, beyond that screen, and adjoining the true wall, was a chaos of huge loose stones, which it was hardly possible to cross. *The entrances to this hidden fastness, which seemed like some ruined colossal amphitheatre, were mere cracks in a wall of rock, so suddenly opened that the upper parts seemed still to touch, and refused to let in the light.* There was abundance of water inside ; and just outside the fissure by which the robbers retired after their attack on the convoy, there was a copious hot spring, wholesome to drink, yet forbidden to the troops by matchlock-men, perched on landing-places in the side of the precipitous crags."

NOTE F, Page 34.

By this is meant, no heat perceptible by bodily sensation. Up to a very recent period, indeed, it was considered that no heat was actually produced by the moon, and various experiments with powerful lenses, directed to the bulb of the thermometer, failed in raising the temperature the smallest fraction. That recent and careful experiments have been more successful, however, we find by the following testimony of Humboldt :—

"That the light of the moon does produce heat, is (like so many others due to my celebrated friend, Melloni) among the most important and most surprising discoveries of our century. After many unsuccessful attempts—from La Hire to those of the acute Forbes—Melloni, by means of a lens (*lentille a èchelons*) of three feet diameter, made for the Meteorological Institution, on the cone of Mount Vesuvius, succeeded, in different phases of the moon, in observing most satisfactory indications of an elevation of temperature. Mosotti, Lavagna, and Belli, Professors of the Universities of Pisa and Pavia, witnessed these experiments, the results of which varied according to the moon's age and altitude. To what amount, expressed in fractional parts, of the centrigrade thermometer the increase of temperature produced on Melloni's thermoscopic pile corresponded, had not then (in the summer of 1846) been examined."—(Humboldt's "Cosmos," vol. iii. part ii. pp. 353-4.)

Professor Piazzi Smythe has more recently (1856) tried on the far greater altitude of Teneriffe the heating effect of the moon's rays on a thermo-multiplier, and with a similar result as that attending Melloni's experiment.

Professor Smythe remarks, with reference to Melloni, that *his* experiment "hardly seems to have received the attention it deserves in this country."

His own plan, together with the result, he describes as follows :—"The plan decided on was to take a larger number of readings at stated short intervals, combined with variations in the direction of the voltaic cone. Having at length obtained about 200 such in the course of an hour and a half, I was extremely well pleased to find that the mean of the numbers *indicated an undoubted heat effect* of about a *third of a degree.* Had the recording instrument been a Fahrenheit's thermometer the whole operation would have been concluded, but as a thermo-multiplier's degrees may be almost anything, I immediately placed a candle on a stool 15 feet in front of the pile, and observing it on exactly the same principle as the moon, there was given a heat of nearly *one degree.* With this result," adds Professor Smythe, "there need be no wonder at the failures of former observers in England, near the level of the sea, and before the day of the thermo-multiplier, to obtain any instrumental evidence of the moon's radiation ; for here, on so peculiarly favourable a position, with the luminary shining away quite blindingly, the heat was only one-third that of an ordinary candle, at the distance stated above."—Teneriffe—an Astronomer's Experiment ; or Speciality attending a Residence above the Clouds, by Piazzi Smythe, F.R.S.S., F.A.R.S., etc. (page 212) ; London, Lovel Reeve.

A more satisfactory proof of the heating power of lunar rays than any instrumental testimony, is perhaps that afforded by the clouds, which, as suggested by Sir John Herschel, seem to be dispersed in the upper regions of the atmosphere, by the presence of the full moon ; the clearness of full-moon nights being obviously due to the radiation of lunar heat, and the consequent dissolving of vaporous clouds. The universal experience of astronomical observers attests this, as also the opposite phenomenon, viz., the re-collection of clouds at the setting of the moon. This I myself witnessed one night at Parsonstown, my attention being called to the fact by a gentleman who was with me, and who, being at the time assistant to the Earl of Rosse at the Observatory, had frequent opportunities of observing the same effect.

NOTE G, Page 42.

The following extract from Mr. Hind's beautiful and interesting little work on the solar system will give some idea of the labour of such calculations :—

"But the most important work undertaken for perfecting our knowledge of her movements, and one which is hardly equalled for magnitude and intricacy in the history of astronomy, is the reduction of all the observations of the moon taken at the Royal Observatory, Greenwich, between the years 1750 and 1830, which has been brought to a completion within the last few years, under the superintendence of the Astronomer Royal. There are about 8000 observations in all, and for the attainment of the object in view, it was necessary to reduce the whole again, with the best modern elements—to compute the tabular places in duplicate, the tables themselves having been modified and extended so as to accord as nearly as possible with M. Plana's theory,—and finally to determine the principal elements of the moon's motion, from the whole mass of observations. Few persons who have not had an opportunity of viewing the manuscripts themselves can form any adequate idea of the enormous labour attending this valuable work. Twelve computers, on an average, were engaged eight hours a day for several years, the reductions having been commenced in earnest in August, 1841, and the last sheets of the second large volume, containing the results, having passed through the press in the spring of 1848."

Note H, Page 80.

That the word *ισαγγελοι*, used in the latter passage, should not be confined to the particular case referred to, is, I think, evident from the very nature of the expression. If man is to be "equal to the angels," we must suppose an equality, not in one but in all particulars. This resemblance opens (without entering minutely into matters with which we are not acquainted) a glorious and happy prospect for man. Selecting only one of those powers which angels we know possess—that of rapid and boundless motion—what a deeply-interesting thought is suggested!

The following passage from Dr. Dwight's "Theology" will best explain it:—

"In Luke xx. 36, our Saviour declares that the righteous will in the *αναστασις*, or future state of existence, be *ισαγγελοι*; literally, 'equal to the angels;' but perhaps intended here to denote, 'like the angels;' that is, possessing in a near and kindred degree the attributes which they possess. Accordingly, in the fourth chapter of the Apocalypse, we are taught that the four-and-twenty elders, the representatives of the ancient and modern churches, are placed round about the throne, together with the four living ones, the representatives of the angelic host. The resemblance here exhibited is such as strongly to exemplify this declaration of Christ. Their station is substantially the same; their employments are the same.

"The activity of angels is disclosed to us by the Scriptures in many passages, and in language of the greatest force. The ninth chapter of Daniel particularly contains, as I observed in the first discourse concerning these glorious intelligences, a remarkable illustration of this subject. Here we are told that Gabriel received a command in heaven, while Daniel was employed in prayer, to interpret his vision; and that 'being caused to fly swiftly, he touched Daniel about the time of the evening oblation.' The activity here declared is plainly superior both to conception and calculation; and exceeds that of the sunbeams beyond any proportion perceptible by our minds. Similar to this representation will be the activity of the righteous in the future world.

"To recur to the illustration adopted in the former part of this discourse. We are now, as we are styled in the Scriptures, worms of the dust; slowly and humbly creeping upon the earth, appointed for our habitation. With these reptiles we die, and are lost in the tomb. Like them also we shall revive to a new and nobler existence! and wander freely at our pleasure through regions shut to us hitherto by an immovable law of our nature, and to our apprehension existing only in argument or fancy.

"To act is the end of all rational existence, and to act at pleasure the necessary concomitant of happy existence.

Like Moses and Elias, if we obtain a part in the first resurrection, we may hereafter visit distant worlds with incomparably more ease than we can now pass from one continent to another; and find the oceans of space by which they are separated merely means of illustrating our activity, and furnishing delightful opportunities of expatiating at our pleasure."—Dwight's "Theology," Ser. clxv. p. 813.

See also Faber's "Many Mansions," p. 134; and Barnes' Note on 1 Peter i. 12.

Note I, Page 81.

That this is the *Scriptural* as well as *rational* view to take of the Apostle's statement, I think there can be little doubt. The earth will not be annihilated by the final conflagration, but renovated, changed, and purified, so as to be rendered a fitting abode for the redeemed; who, united to their new bodies, although not necessarily confined to the earth, will inhabit it as their happy home for evermore; where Jesus will be their King and Lord, and all his power and goodness, which we see so wonderfully exhibited to us here, will be put forth to embellish and adorn the place consecrated by the memory of his dying love, and henceforth a fitting antitype of the paradise of God, in the midst of which he sits as the tree of life, to dispense happiness and blessing unspeakable to the thousand times ten thousand immortal beings whom he has saved. Any attempt, indeed, to describe the precise nature of the change that will be made in our planet, in order to produce this, would be as vain as to endeavour to explain the nature of the bodies we shall then possess. But that it will be this identical material world is, I think, as plain as that we shall be our identical selves, and is evident from the testimony of Peter, as of many other parts of Scripture; and in some degree, indeed, it is not so difficult to imagine a paradise composed of a greater amount of glory and beauty imparted to scenes resembling those with which we are familiar here. We have only now to select one of the most beautiful of those spots that we can recall to our memory on earth—to choose the moment when it looks most to advantage, to invest it with the sweetest and most cherished and hallowed associations, to take the happiest and most buoyant and delightful moment of our existence, when no cloud was upon our mind, no care was on our brow, or sickness in our frames, or sorrow in our hearts—we have only to surround ourselves with the friends and relatives we love best in the world—to banish sin altogether, and, above all, to add the presence of Him "whom, not seeing, yet we love," and write upon all this the word PERMANENCE, and our happiness would be complete; we should "rejoice with joy unspeakable and full of glory," and earth would be at once a paradise.

The opinions of many eminent theologians are in accordance with these views. Thus Dr. Thos. Burnet says:—"I know it is the opinion of some that this world will be annihilated, or reduced to nothing, at the conflagration, and that would put an end to all further inquiries. But where do they learn this?—what instance or example can they give us of annihilation?—or what place of Scripture can they produce that says the world in the last fire shall be reduced to nothing? If they have neither instance nor proof of what they affirm, it is an empty imagination of their own, neither agreeable to philosophy nor divinity. Fire does not consume any substance; it changes the form and qualities of it, but the matter remains; and if the design had been annihilation, the employing of fire would have been of no use or effect, for smoke and ashes are at as great a distance from nothing as the bodies themselves out of which they are made."

With regard to the Scriptural evidence, he continues:—"The prophets both of the Old and New Testament have left us their predictions concerning 'new heavens and a new earth.' So says the prophet Isaiah—'Behold I create new heavens and a new earth, and the former shall not be remembered or come into mind (chap. lxv. 17), as not worthy our thoughts in comparison of those that will arise when these pass away.' So the prophet John, in his Apocalypse, when he was come to the end of this world, says—'And I saw a new heaven and a new earth, for the first heaven and the first earth were passed away, and there was no more sea' (Apoc. xxi. 1); where he does not only give us an account of a new heaven and a new earth in general, but also gives a distinctive character of the new earth, that it shall have no sea; and, in the fifth verse, He that sat upon the throne says, 'Behold I make all things new!' which, considered with the antecedents and consequents, cannot be otherwise understood than of a new world."

With reference to the allegorical mode of interpreting the promise of the new heavens and earth, he says:—"Here is no room for allegories or allegorical expositions, unless you will make the conflagration of the world an allegory; for as heaven and earth were *destroyed*, so heaven and earth are *restored*, and if in the *first* place you understand the *natural material* world, you must also understand it in the second place—they are both allegories, or neither; but to make the conflagration an allegory is not only to contradict St. Peter, but all antiquity, sacred or profane; and I desire no more assurance that we shall have new heavens and new earth in a literal sense than we know that the present heavens and earth shall be destroyed in a literal sense, and by material fire. Let it, therefore, rest upon that issue as to the first evidence and argument from Scripture."—(Burnet's "Theory," pp. 516-18.)

The following beautiful passage, from a modern commentator, confirms the foregoing idea:—

"That the earth may again be revisited from time to time by the redeemed, that in a purified and renovated form it may be one of the 'many mansions' which are to be fitted up for them (John xiv. 2), may not appear wholly improbable from the following suggestions :—1. It seems to have been a law of the earth, that in its progress it should be prepared at one period for the dwelling-place of a higher order of beings at another period. Thus, according to the disclosures of geology, it existed perhaps for countless ages before it was fitted to be an abode for man; and then it was occupied by the monsters of an inferior order of existence, who have now passed away to make room for a nobler race. Who can tell but the present order of things may pass away to make place for the manifestations of a more exalted mode of being? 2. There is no certain evidence that any world has been annihilated, though some have disappeared from human view. Indeed, as observed above (Notes, ver. 10), there is no proof that a single particle of matter ever has been annihilated, or ever will be. It may change its form, but it may still exist. 3. It seems also to accord most with probability, that, though the earth may undergo important changes by flood or fire, it will not be annihilated. It seems difficult to suppose that, as a world, it will be wholly displaced from the system of which it is now a part, or that the system itself will disappear. The earth, as one of the worlds of God, has occupied too important a position in the history of the universe, to make it to be easily believed that the place where the Son of God became incarnate and died shall be utterly swept away. It would, certainly, accord more with all the feelings which we can have on such a subject, to suppose that a world once so beautiful when it came from the hand of its Maker, should be restored to primitive loveliness; that a world which seems to have been made primarily (see Notes, 1 Pet. i. 12) with a view to illustrate the glory of God in redemption, should be preserved in some appropriate form to be the theatre of the exhibition of the development of that plan in far distant ages to come. 4. To the redeemed, it would be most interesting again to visit the spot where the great work of their redemption was accomplished; where the

Son of God became incarnate, and made atonement for sin ; and where there would be so many interesting recollections and associations, even after the purification by fire, connected with the infancy of their existence, and their preparation for eternity. Piety would, at least, wish that the world where Gethsemane and Calvary are should never be blotted out from the universe. But (5.) if, after their resurrection and ascension into heaven, the redeemed shall ever revisit a world so full of interesting recollections and associations—where they began their being, where their Redeemer lived and died, where they were renewed and sanctified, and where their bodies once rested in the grave, there is no reason to suppose that this will be their permanent and unchanging abode. It may be mere speculation, but it seems to accord best with the goodness of God, and with the manner in which the universe is made, to suppose that every portion of it may be visited, and become successively the abode of the redeemed; that they may pass from world to world, and survey the wonders and the works of God as they are displayed in different worlds. The universe, so vast, seems to have been fitted up for such a purpose, and nothing else that we can conceive of will be so adapted to give employment without weariness to the minds that God has made, in the interminable duration before them."—*Barnes on* 2 *Peter* iii. 10.

The following extracts from the correspondence which took place between Mr. Nasmyth, of Manchester, and myself, upon the subject of the Lunar Surface, will be read with interest :—

" *Fireside—Patricroft, near Manchester,*
Nov. 5, 1853.

" DEAR SIR—I have to thank you most sincerely for your very valued note, and the copy of your very interesting little book upon the Lunar World, which I have perused with the highest pleasure. Although there are some matters in it that do not accord with my experience and views on the subject in question, yet, on the whole, I agree, and consider it the best exposition of the subject I have met with, especially in respect to the admirable spirit and tone which pervades it; and I esteem it as a high compliment, that you have thought me deserving of a presentation-copy. I have, indeed, devoted very special attention to the subject of the investigation of the Lunar Surface. It has engaged all the leisure time and thought which I have been able to devote in that matter during the last fourteen years; and, early and late, I have seldom let slip a chance of adding to my store of observations; and, by the aid of home-made reflecting telescopes, of all capabilities, from 7 in. up to 20 in., I have aided myself with means of plying her wondrous surface with questions; and have received answers such as have kept me cogitating and considering till the next opportunity occurred to ask her a few more, and so clear up doubtful points, that have presented themselves between my reflections, on what I had had so gloriously laid before me by the aid of such *amply* powerful means as a 20 in. diameter reflecting telescope could yield me. I am glad to observe you have made an attempt to realize lunar landscape and scenery, as it would appear were we 'there to see.' I also have done something in this way.

"I cannot imagine any subject more glorious to feast the mind's eye upon, than to wander, in thought, amid the fearfully grand scenery in the moon; and any one who is artist enough can do so, from what is revealed to us by the telescope; in fact, this is to me the chief charm of the pursuit—not an indulgence of 'mere wild fancy,' but a most legitimate exercise of the reason, and most legitimate powers of the imagination. And having, in my travels, seen the actual results of volcanic action, extinct and active, I think I can comprehend what I observe on the moon, and trace the analogy where it is applicable, and where it is not, in respect to similar evidences in the moon. To give you all my reasons would exceed the limits of your patience and my present opportunity; but I may convey to you one of my most definite and strong convictions, in a few words—namely, *that I do not believe there is one of the countless thousands of volcanoes, whose craters bespatter the lunar surface, in action, or has been in action for thousands of ages past.* I am vain enough to think I have got the right view of the true nature of volcanic action; and it is a view which close observation of the phenomenon in all its phases has impressed on me—namely, *that volcanic action is an expiring phenomenon,* having for its cause and source great cosmical principles, quite independent from any mere chemical action; and, in that view, I consider molten lava and the heat of volcanic action to be nothing less than the residue of that igneous state through which *all* planets have passed, in their cosmical history, from the earliest moments of their creation to the present time. And, in this view, if our globe be permitted to exist, in its present condition, for ages to come, volcanic action as an active phenomenon will dwindle away, and finally cease to exist—the solid crust of the earth so increasing in thickness as to prevent the issue of any of the yet remaining molten matter from its interior.

"The moon, from its small mass, and proportionally great surface, must have cooled down vastly more rapidly than the earth; and all have been dead, tranquil, and silent for countless ages, ere we had passed over our rampant volcanic era, of which our most tremendous modern volcanoes are but mole-hills in comparison. Look at Antrim, and the north-west of Scotland—the remains of vast successive sheets of lava! belched forth from age to age, even in a comparatively recent geological period—*i.e., after* the chalk formation! it was well and benevolently ordained that man should not be called forth ere all this dread period was past and over. In my opinion, no changes whatsoever are in progress in the moon—*no water, no atmosphere;* therefore, no *soil,* no vegetation, and no inhabitants. And as to temperature, fierce sunshine; and then fourteen days of x degrees below Zero;* for, with no atmosphere, no water, and no dew, the heat yielded by the sun must pass off into space, with a rapidity of which we have no conception; and an intensity of cold come on that is equally beyond our power to conceive. Such alternations must be quite irreconcilable with life in any form we know of."

With regard to the question of shadows thrown by the rays from Tycho, etc., Mr. N. says:—

"I cannot say that I have ever observed any shadows from the bright rays, *i.e.*, cast by them when just emerging into sunshine. I have watched for this, but never met with any indication of shadows; nor am I surprised that such is not very evident, as they must be of very low elevation.

"Several years ago, I communicated a paper to the Royal Astronomical Society, on the cause of those bright streaks which radiate from certain craters; and I am happy to find my views on this and other points of the subject, are received, by our highest authorities, as standard ones—namely, that the bright streaks are the result of the exudation of very fluid lava up through the cracks, simultaneously along their entire course—in the same way as water would come up through cracks in the ice resting on the surface of water below. The chief discharge would be from the point of divergence, where, or under which, the focus of disruption lay; and, in consequence, become the seat of a vast crater. I have cracked hermetically-sealed glass globes, filled choke-full of water, by expansion; and the result is truly beautiful—so *perfect* a realization of the Tychonic or Copernican rays, even to the minute features of resemblance, the non-radiality of the cracks when near the focus of disruption resulting from the point of least resistance not being a point, but rather an area of least resistance, about which the cracks did not, as it were, know where to begin their course of divergence. If you will narrowly inspect Tycho or Copernicus, on any of these features, you will observe what I allude to—namely, the non-*absolute* radiality of the bright streaks. It is from the very fact, that the breaking up of the surface was from underneath that these streaks have no regard to surface inequalities, running through and over hill and dale, with the same integrity of original direction as if no surface-feature had any influence—neither had it. The molten matter would come up just as our basaltic dykes have done, and spread somewhat at the surface; so that a crack of twenty feet wide might yield a streak of a mile wide, or so, according to the fluidity of the lava. I look upon these streaks and bright craters as the most recent, so to speak, of the lunar features, as the last discharges would consist of the most dense, and therefore most reflective, matters.

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* I use this expression of the unknown quantity as most fitting the state of our knowledge on the subject.

"In the enclosed paper, on the subject of the probable present temperature of Jupiter, you will find this great principle, which, I believe, I am the first to expound, as to the law of the rate of cooling of planets—namely, the dependence of the rate of cooling upon the *square* and *cube* of the diameter of the planet—a consideration of the highest importance, and one I am surprised was left to me to point out. If you will reflect on what state our earth was in ere it had cooled down to 212, you will find, as I think, some light thrown upon the second verse of Genesis, when 'darkness was upon the face of the deep;' for, during countless ages, no ray of light could ever penetrate the thick envelope of vapour, containing, as it must, all the water that *was* to form our ocean when the 212 era was attained. In this pre-oceanic period, then, was it that 'darkness was upon the face of the deep;' and even after we had received our ocean, the thick masses of vapour from its hot waters must have held all in darkness, till the temperature had so far gone down as to permit 'the first ray' to burst through. What a glorious subject for a picture this 'first ray' would form! and the awful scenes when, in the pre-oceanic state, 'the most thick darkness' was lit up by the lurid glare of mighty volcanoes belching forth their molten floods down the rugged sides of the primitive mountains—so terribly high, by the addition of the oceanic valleys added to the height; and then, again and again, the transitory visits of the ocean, pouring down in wild cascades, every drop a bucket of water; for, by the radiation of the heat into space, from the exterior of the vapour envelope, the waters must have again and again come down by the rush on the hissing, hot earth. No wonder the primitive sedementary strata are of such vast thickness; I take it, they are formed of the *mud* of these very pre-oceanic floods."

"Red hot ball"—(page 11, line 6.) Mr. N. suggests, that a *white* hot ball would be nearer the mark, which, relieved by a pitchy black sky, would certainly have a novel and strange appearance. I have no doubt that this is the truth, and accordingly insert his statement, as it has an important bearing as to the non-existence of a lunar atmosphere:—

"According to my view of the subject, the sun would be seen from the moon more brilliantly than it is ever seen at twelve in the day in a tropical country; for, as there is no atmosphere in the moon, there would be no medium to rob its rays of any of its primitive purity and brilliancy, and the sun must shine upon the lunar scenery with a brightness, of which we can form but little conception; so that there will, under no circumstances, be any appearance of a *red* hot ball. I am the more anxious you should correct this, as it tends to contradict one of the most marked, and as I think clearly established facts, as to the state of the moon in regard to absence of all appreciable evidence of atmosphere. I have paid most especial attention to this part of the subject, and have watched vast numbers of occultations, and have never seen the slightest trace of colouring of the most brilliant or the most delicate stars, at the last instant of disappearance, nor have I ever observed the dwelling on the edge, or overlapping, which have been so often stated. The latter phenomenon I believe has its origin in the peculiar vision of the observer, as, when steadfastly keeping the eye upon any bright point, it is apt to make an impression on the retina, and remain for a few moments when the object is gone. This I take to be the true explanation of the phenomenon in question. I have also most carefully watched the passage of the sharp edge of the moon over delicate features on the solar spots, such as happened to be on the sun on occasions of solar eclipse, and not the slightest distortion was observable, nor the least muzziness of the edge of the lunar disc, so clearly defined and relieved on the brilliant background. Again, the remarkable whiteness and brilliancy of the tips of mountains, as they come up into the sunshine, as the smallest specks of light. Now, if there was any atmosphere, however attenuated, we should have a fading of the brilliancy in such position of the mountain tops; nothing of the kind is visible."

"Stars sparkle"—(page 11, line 7). I take the opportunity here afforded of correcting this expression, according to Mr. Nasmyth's suggestion, who thus states his view of the matter. (There is, however, a great difficulty in getting out of our own planet, even in imagination):—

"With respect to 'the sparkling' of the stars, as seen from the moon, there will be *no sparkling*, but on the contrary, the most tempting steadiness in their brilliancy; they will shine so bright and steady as to harmonize admirably with the death-like stillness that will reign around. If any sound could ever be heard there, it would be, perhaps, now and then a slight cracking, from the contraction or expansion of the rocks, as the fierce heat of the sun gives way to, or succeeds, the terrible intensity of the cold, that will come on so rapidly as soon as the sun has set to the part in question. This action, I take it, is the only one now in operation on the moon as an agent of disintegration; but it must even now be almost gone by, as all that would be subject to such alternate influences must have attained a final condition ages ago.

"The shadows of the moon must, indeed, be intensely sharp and black, only that there will be, to a certain degree, a penumbral border to the shadows, owing to the vast disc of the sun; *absolute* sharpness could only exist when the light comes from a *point.* In this respect, the sharpness of the shadows of objects in Neptune must be almost perfect—no penumbral edges there! I have looked with much interest to the aspect of shadows by objects lighted by the electric or oxyhydrogen light; in this case the shadows are wonderfully acute, by reason of the point-like magnitude of the source of the light. Again, let us not forget, in speaking of the perfect blackness of the shadows on the moon, that such shadows are at all times lit up, or modified in their intensity, by the *earthshine,* which is sixteen times more bright on the moon than the *moonshine* is with us; so that the fourteen days' long night on the moon must be lit up by the *earthshine,* in a magnificent manner, and yield an aspect of lunar landscape of the most sublime and melancholy grandeur.

"With respect to the colour of various parts of the moon, I cannot say that I have observed any very marked *colours*; all I can speak to is the variety of the degree of illuminative or reflective powers, and in some districts a tendency to a *brownish* tint. No doubt if we were near enough we should behold the colours of the volcanic crust of the moon most varied and brilliant. I well remember being struck with this when I spent two days sketching down inside the crater of Vesuvius, at a time when there was no action, save muriatic and sulphurous acid gas rushing forth from the terrible hole, down at the side of which I stood, with a scene around me that I shall never forget; the brilliancy and variety of tint of the colours of the rocks of lava were beyond all description; and so will it be, no doubt, in the moon, were we there to see. With respect to the colour of the sky, as seen from the moon, it must be *absolute blackness*, as you would from such a point of view look right into space, with no medium intervening; and myriads of stars that are rendered invisible by the opposition our atmosphere presents to their delicate light reaching us, would then become cognizable, as they do in a telescope of large aperture.

"Yours most truly,

"JAMES NASMYTH."

"The Rev. J. Crampton."

NOTE, page 90.

I may here illustrate the different aspect of the lunar surface, as seen with a superior telescope, and one of average or even very considerable power. The following is an extract from a letter received from Mr. Nasmyth in the early part of this year (1862):—"By aid of the 20 inch Trunian Nasmythian Telescope, which I have worked to a high state of perfection, I have, with a power of 320 to 400, got sight of details I *never saw before*—at least, with anything like the sharpness. I find almost the entire surface that *used* to appear comparatively smooth and devoid of feature, to be, as it were, *frothed over* with myriads of minute (so to speak) craters. Frothed over is not a far-fetched expression for it, for they look to be *con-*

solidated effervescence ; and no doubt in some sense they are so ; only, what we call a minute crater on the moon is doubtless at least half to quarter of a mile from wall to wall."

Mr. Nasmyth also states that he has discovered many cracks so minute as to be, in proportion to those he has formerly seen, as the mere stroke of a pen to a width of about the tenth of an inch.

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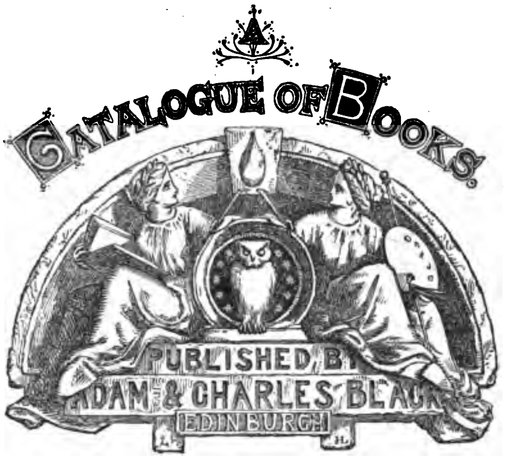

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